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By W. H. M. Watson

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Industrial Progress . . . Metal Price Indices . . . Statistical Review

"A little extra ain't too much!"

And that reminds us of Mrs. McCarthy, whose one aim in life seemed to be making others happy. As Pat, who had been a shift boss for 20 years, was bundling himself up to brave the wintry blasts, Mrs. McCarthy stood there with a large apple in one hand and a loaded dinner pail in the other.

"Here Pat, put this apple in yer pocket; there ain't room in the pail." "I won't need that apple, Ellen, a pailful is enough fer any man," said Pat. "Oh, take it anyway—a little extra ain't too much, and besides somebody may enjoy it," she replied.

That day there were several air blasts in the mine, loose ground blocked the skipway, and it was 8:30 that evening before the skip could be released and hoisting resumed. In Pat's own words, "the little extra lunch was a Godsend,"

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How Big Is the Mining Industry?

WITHOUT SUBSCRIBING to the unkind implication in the epigrammatical sequence "lies, damned lies, and statistics," one may point out that statistical deductions frequently are misleading. Recently a compilation was prepared ranking American industries "in accordance with revenue or value of products." The mining industry, excluding fuels, solid and liquid, ranked far down the list in the twenty-eighth place, below boots and shoes, and butter and cheese. Naturally somewhat jealous of the importance of the industry, we undertook to analyze some of the data.

In the first place "value of product" hardly seems an equitable basis for comparing industries that produce raw materials with those that produce finished manufactured goods. For example, one dollar's worth of virgin refined copper and zinc may be converted into two dollars' worth of sheet brass, which in turn may be manufactured into three dollars' worth of electrical supplies. On the basis of value of the product, the electrical manufacturing industry is three times as important as the metal mining and refining industry, whereas, in fact, the two are equal.

The fourth largest industry, according to the table, is slaughtering and wholesale meat packing, with a product valued at $3,050,000,000. It is evident, however, that the animals delivered to the packing house on the hoof are worth well over half the total. Petroleum refining, sixth on the list, is rated at $2,376,000,000; but from this should be subtracted the value of the petroleum at the well, and the cost of transportation to the refinery, amounting to no less than $1,000,000,000. Automobile manufacturing is fourth in the table, with $3,198,000,000, whereas railroad operation is third, with $6,380,000,000, which presumably is revenue. However, the railroads employ almost ten times as many men as the automobile manufacturers—1,782,000, against only 197,728. A reasonable deduction from this comparison is that the cost of raw and semi-fabricated materials, and equipment manufactured by electrical and other industries, forms the preponderant part of the value of the motor car; and that on the basis of what it contributes directly to the factory value of its product, the motor-vehicle industry is not as huge as it generally is given credit for being.

How big is the mining industry? According to "Mineral Resources," published by the Department of Commerce, in 1926 the United States produced metallic products worth $1,402,000,000 and non-metallic products, exclusive of mineral fuels, worth $1,231,000,000, or a total of $2,633,000,000. The first item includes pig iron as well as iron ore; but, after making a deduction for the pig iron, approximately $2,000,000,000 remains as the value of metals and non-metallic minerals, aside from fuels.

Considering the mineral industry of the United States as a whole, the value of its products in unmanufactured form is more than $9,000,000,000, which places it second only to agriculture, with $12,400,000,000. General construction, incidentally, is third in the table, with $6,380,000,000. Or, on the other hand, consider the $2,000,000,000 represented by metal and non-metallic mining alone. It exceeds by a considerable margin each of the following: coal, including bituminous and anthracite; electric light and power; lumber and timber products; petroleum and natural gas. These, with agriculture, may be regarded as forming the roster of primary industries that produce by exploitation of natural resources as distinguished from those that produce manufactures from raw materials that they purchase.

Whatever view is taken, "mining," in the broad sense, as covered by *Engineering and Mining Journal*, looms as one of the most important elements in the industrial structure of the United States and of the world.

Broadening the Appeal of *Mining Journal*

A DEFINITION of the function of a technical journal would be difficult to frame. Some elasticity in scope is essential, but nothing can hide the obvious fact that the physical opportunity for the publication of information is a limited one. In common with any other commercial enterprise, expenditure must be considered in respect to income, and it should not be forgotten that production expenses are mounting yearly. In consequence, the number of pages per issue available for technical articles cannot be increased without incurring heavy additional cost and economic disorganization.

These facts are occasionally overlooked by the contributor, who naturally views the problem in terms of his own specialty and fails to appreciate the circumstance that the publication of an article of undue length, or in several installments, automatically inhibits the appearance of many shorter articles on other subjects, occasionally causing widespread disappointment if not resentment. To please everyone is perhaps an impossibility, but *Mining Journal* intends to make every possible effort in that direction. To achieve some measure of success in catering to so wide and varied a field of readers, however, it becomes necessary to discourage the type of contribution that absorbs excessive space, whatever its intrinsic merit, so that, as far as possible, each issue may have an appeal to every type of reader. This ideal may be impracticable of attainment, but the effort to reach it can and will be made. The result may not meet unanimous approval, and this will be deplored and regretted; but it is felt that a more general satisfaction will result.

Space is not available for the records of elaborate and

deep research, on the one hand, or for detailed historical statements, on the other, articles on either of which should appear in the transactions of the scientific and professional societies.

Material technically worth-while and suitable for publication in book form is seldom appropriate for publication in a weekly magazine. The specialist in the mining or the metallurgical field is inclined to resent the appearance of too much material on a subject in which he is not interested. Our readers and contributors will appreciate the situation, it is felt, and will be willing to co-operate in our desire to mold policy in line with a logical program to insure the greatest good to the greatest number. Comment and suggestion from contributors and readers will be appreciated.

On Programs of Society Meetings

IN ADDITION to an audience and speakers on the program, two things are necessary if a convention is to be successful. First, the audience chamber should be so located and ventilated that it is possible for the listener to concentrate on the speaker without falling asleep. This requirement is so elemental that it is sometimes overlooked. Further, the topics selected should meet the desires and needs of the listeners as closely as can be ascertained. This principle was perhaps not observed as fully as it might have been at the geophysical symposium that marked the recent meeting of the Institute in New York. The size of the audience assembled on that occasion bore witness to the popularity of the subject. Geophysics is deservedly popular because its application to the quest for ore has been of valuable assistance to the mining industry with respect to this vital matter. Those who gathered to hear the speakers hoped to learn something that might be useful to them in their work. Did they get it? An unqualified negative answer would be unfair, because some of the papers were undoubtedly helpful to the average mining man. As for the others, however, a suspicion exists that they had been prepared by physicists for physicists and not for the mining man at all, save possibly to impress upon the latter that he stands no chance of mastering the subject, but must rely upon the physicist as an interpreter.

What the engineer and mining man would like to see is the development, out of the confusing welter of theory and mathematics, of some practical working rules, the possession of which would stabilize him with respect to the geophysicist and the latter's science. Papers reciting endless detail, splitting hairs, and making fine distinctions should preferably be kept for entertainment of the esoteric circle.

The result will be the same whether a paper be unsuited to the audience or the audience to the paper. An instance where the speaker would have preferred a different audience occurred at the New York meeting. This was at the session on mining geology, when Dr. Lindgren expressed a wish that he might have been permitted to speak to mine operators and engineers, rather than only to fellow geologists, on his chosen topic of the necessity for geological research. No need existed for "selling" geology to geologists. But some missionary work, he felt, might have been accomplished among the mining men had not other conflicting sessions kept them from attending.

University Activity in Industry

A LETTER addressed to a contemporary contains the following questions: Should university professors be permitted to act as consultants for industry while serving the state as educators? Can our educational institutions be adequately served while our professors are spending their time and energy in consulting practice? Is it fair to penalize the teaching professors by making it necessary for them to do consulting work in order to supplement an inadequate salary? Is it fair to the independent engineer to be put to a disadvantage by the competition of university professors in industrial work? At the same time, it may be contended with some justice that contact with outside activity is necessary to keep the professor abreast with progress in his industry; and that, on the average, men of higher caliber can be obtained as teachers if outside professional work is permitted, which may or may not interfere with educational routine duties.

This subject calls for thoughtful consideration by all who are concerned with the proper conduct of the various institutions of learning and instruction in the United States, or with the rights of the individual or the corporation to protest against an invasion of a professional or an industrial field. Two sides of the problem will be presented, with arguments indicating interests that are diametrically opposed to each other. *Mining Journal,* however, cannot ignore the fact that a vast amount of dissatisfaction at existing conditions is being shown by many who view the spare-time efforts of paid instructors outside the educational field as an encroachment on professional and industrial practice and as a menace to their means of livelihood.

As an example, we have been advised that the director of a department in a certain educational institution supported by state funds is being paid $300 per month for half of his time. In the other moiety he is free to carry out professional work of any kind, in direct competition with practicing engineers. To prevent the interruptions to instruction that result by reason of the absence of the director, an assistant director has been appointed. A professor of metallurgy at the same institution also draws $300 per month, and, as might be expected, engages in general consulting work. Regarding these two state officials and their work a correspondent writes as follows:

"Since they are permitted on their 'own time' to do work at a test plant for all the world, to say nothing of the work that they do after school time without getting a substitute, but merely working at preliminary business, and the mere fact they have the laboratory and test plant available by the payment of an insignificant laboratory charge, and an assay office for the mere pittance of 60c. per determination to do their assaying, plus the drawing power of the institution in question to secure their work for them under the guise of an impartial, unbiased opinion, it is impossible for me to condone these activities."

Mining Journal places the foregoing information and comments before its readers in the hope that a thorough consideration of the problem and frank expressions of opinion from leaders in the mining industry will help to mold policy and practice in this connection at our educational institutions, to the advantage of all concerned and with unfair detriment to no person, class or profession.

Ventilation and Air Conditioning—Mental and Physical Efficiency

THE national Senate and House of Representatives have realized the importance of conditioning the air in the legislative chambers, and a committee of prominent engineers and health officials has recommended plans that will doubtless be put into effect. Thus the lawmakers will be able to work in an atmosphere that should help rather than hinder clear thinking and prompt decision, and decrease the hazard of contraction of minor infectious ailments. It is probable that the system adopted will resemble that in use at some of the larger theaters, where a constant flow of water-washed air, cooled and conditioned, is circulated through the building, entering at many points on the floor and passing out through ports in the ceiling or roof. The benefits of a modern system of air control will be appreciated by those who have visited the Roxy theater in New York, and who have noted the atmospheric and temperature conditions in this fine example of engineering technique and accomplishment.

A recognition of the need for scientific air conditioning and its movement through buildings occupied by humans engaged in mental or physical tasks, or at recreation, is the soundest index to sane thinking and humanitarian impulse. The loss of efficiency in general industrial and clerical work as a result of the stagnancy of the surrounding atmosphere is appalling, though unrealized in most quarters.

Early physiological experiments conducted by Dr. Leonard Hill demonstrated without doubt the important fact that to insure maximum mental and physical effort, and the minimum of fatigue, an atmosphere must be in motion. Atmospheric stagnancy is synonymous with many other types of stagnancy. Even in a foul and polluted atmosphere, movement of the air brings instant relief.

The second and equally important factor is temperature. It must be reasonably low. The third factor is humidity—one that affects economy as well as personal efficiency. The distress caused by high heat and high humidity in many summer climates is well known. In winter, however, the heating of an already dry air produces rapid body evaporation and a sense of chill; whereupon it is usual to supply more heat, until mental and physical effort becomes distasteful and the attainment of apparent bodily comfort finally becomes the only desideratum.

The waste of fuel arising from the overheating of dry air, producing an atmosphere in which circulation is secured merely by waves of heat from radiators, calls for remedial action. Greater comfort, greater efficiency, and lower cost would result if a more general recognition were made of the need for (1) a moderate temperature; (2) a moderate humidity; (3) and atmospheric movement. Science and engineering have provided the means whereby they may be obtained at a cost that will be returned in improved working result and greater comfort, whether in the factory, in the office, in the dwelling, or in the mine.

Hotels, convention rooms, the smaller theaters, and other places of entertainment are invariably overheated and underventilated. The discomfort resulting is apparently due to a lack of knowledge and a failure to move with the times. The Pullman company is an outstanding offender, the temperature maintained in its coaches being much too high. A speaker at Denver recently remarked, apropos of a personal experience, that it had achieved the remarkable feat of transporting thither a carload of air from Omaha without losing any on the way! Complaints are general; travelers are unsparing in their caustic criticism of a condition that the company in question makes no attempt to remedy, despite high charges for service. No wonder that many prefer the auto bus and look forward to the time when a wider use of the airplane will become practicable.

No excuse can be offered for a lack of knowledge of the elementals of hygiene in these days of fact finding and wholesale publicity. The thermostatic control of temperature and the conditioning of air, when generally adopted, will effect immense savings in fuel and secure greater comfort and efficiency, with a corresponding decrease in sickness.

The professional ventilating engineer is undoubtedly well qualified to step into the breach, with plans and advice; the manufacturer is ready to meet and solve any class of problem presented. It is time that employers in general and those catering for the transport, entertainment, and housing of human beings, in particular, should investigate existing conditions and take appropriate action.

The Hazard of Cheap Explosives in Mining Operations

THE manufacture of explosives for blasting is a highly technical operation, with a background of research extending over many years. Without close control and without experience in manufacture, it would be dangerous to undertake; and it would involve hazard to users unless the reputation of the manufacturer carries with it a guarantee that the new product has been tried under various conditions of service and that it is as safe to use as any other established and extensively used explosive of similar grade.

Uniformity of product and freedom from constituents that cause decomposition, as well as the use of constituents the actions of which are well known within the limits established by custom and use, are essential requirements of manufacture. Certain compounds that could be used in the manufacture of explosives are not so used because they deteriorate or set up conditions that render them unsafe as compared to others which by long experience have been found suitable. Most established explosive manufacturers have a background of experience, and submit new products to rigid tests before placing them on the market. The reputation of an explosives manufacturer rests on long service in supplying dependable products. As all explosives are dangerous, the purchaser depends on the skill, experience, and carefulness of the manufacturer—on his reputation and industrial standing.

That new explosives will continue to be developed is a reasonable expectation. The liquid-oxygen explosive is a case in point. Recently a manufacturer announced a series of grades of a new explosive designed to secure lower costs to operators. Competition is served best thus; but if lower cost connotes increase in risk to the operator, there is retrogression. Experienced manufacturers realize the fact and adhere to the principle that lower cost must not be permitted to involve greater hazard to the user.

Richard Pearce

The Biographic Sketch of a Pioneer Metallurgist

By T. A. RICKARD

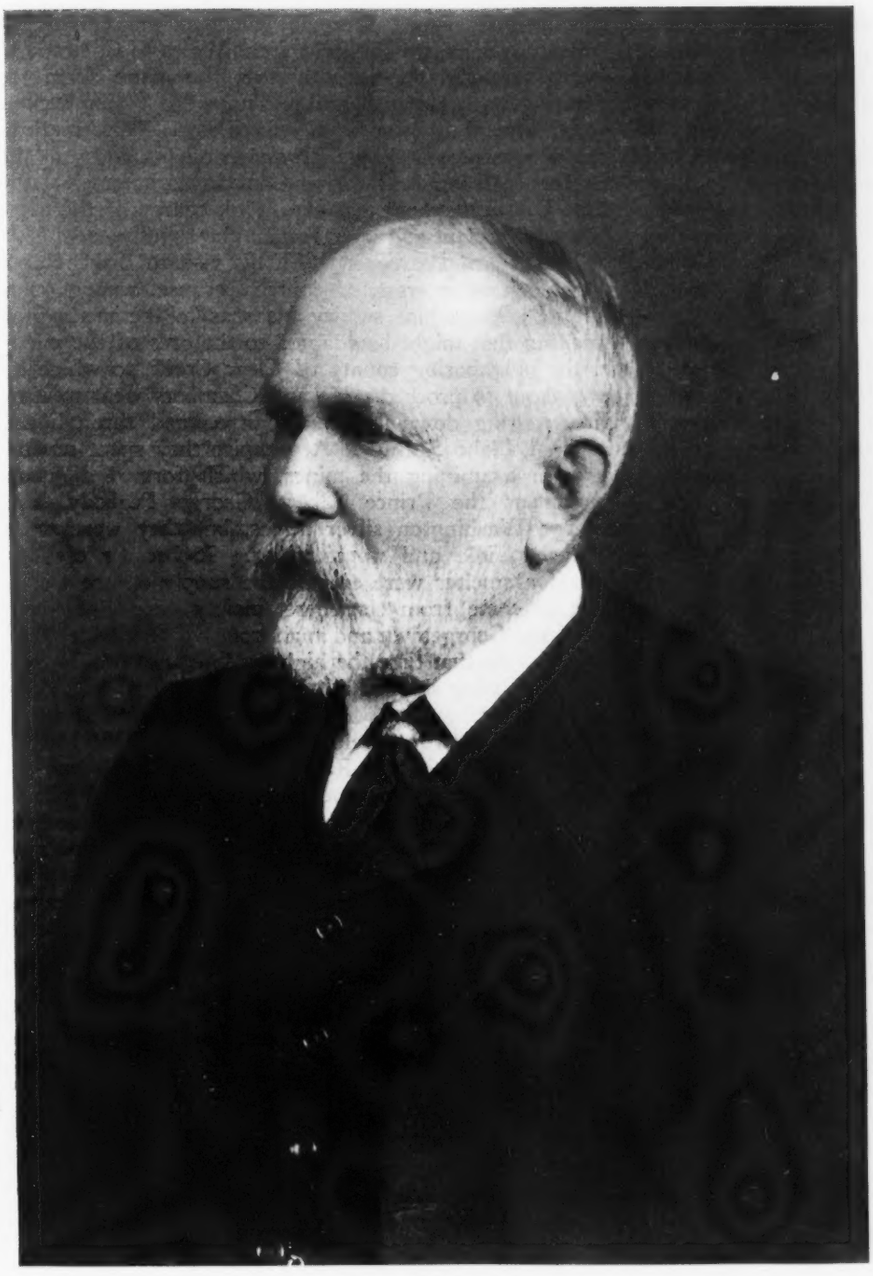
RICHARD PEARCE was born on June 29, 1837, at Barrippa, near Camborne, in Cornwall. Like many Cornishmen, he inherited a taste for mining from his father, Richard Donald Pearce, who was one of the mine captains of Dolcoath, the premier tin mine of Cornwall. An ordinary common-school education was terminated by his employment at the age of fourteen in the tin-dressing department of Dolcoath, where, as he says in his biographic notes, he "became practically conversant with the different stages of tin dressing then in vogue" and developed "a fondness for minerals and chemistry." In 1855 an attempt was made to revive the mining school at Truro, the capital of Cornwall, but the lack of interest in technical science shown by the mine managers throughout the county proved a deadly obstacle. Much to this own surprise, the boy of eighteen was appointed assistant in chemistry. He went to work in earnest and soon learned enough to perform his duties acceptably, all his spare time being devoted to intensive study. Unfortunately, for the reasons already stated, the school was discontinued at the end of the third year, but it left the young Richard Pearce much enriched in knowledge and experience. He enjoyed the friendship of the students, most of whom were many years his senior, and the good will of the professors, as we shall see.

"I SHALL always remember with much pleasure," he says, "our meetings at the rooms of the students, where we frequently, after a liberal 'tuck-in' of tea and toast, sat around the table, which was covered with a large white sheet, in the center of which was put a block of china clay, or kaolin. Every member of the party would cut a square block of the clay into some well-defined form, or model of a crystal. Starting with a carefully shaped cube, for example, it was interesting and instructive to watch the gradual development of the faces of the octahedron, trapezohedron, and tetrahedron by the cutting of the angles, or beveling the edges, until the new figures were complete. My mathematics were always obscure, charts and diagrams with figures I could not grasp, but I shall never forget the pleasure I felt in watching the gradual development of a series of new faces by the skilful use of a knife on a piece of china clay. I can see before me now my great triumph when I completed the 48-sided figure, the hexakisoctahedron, by the gradual replacement of the angles of the cube by six planes at proper angles, and then the hardening of the surface of the clay model by painting it with bee's wax dissolved in oil of turpentine."

When the school closed, Richard Pearce returned to Delcoath as assistant to his father, his chief duty being the assaying of ore samples, by means of the vanning shovel. His life, he says, was "dull and monotonous"; there was not much to learn except mineralogy, to which he applied himself vigorously. He was not in sympathy with his associates, most of whom were the kind of men that call themselves "practical" as an excuse for ignorance. However, he did not remain long at the mine, for late in 1858 he was summoned again to Truro to confer with the committee of the Royal Institution of Cornwall in regard to the establishment of local schools, or classes, at the various mining centers of the county. The proposal emanated from Dr. C. Barham, with whom Richard Pearce formed a lifelong friendship. He was selected to start classes, as proposed, and also to give a course of more advanced instruction during winter at the rooms of the Royal Institution itself. He started his first class at St. Just, where he soon won the hearty co-operation of the gentry of the locality and of the miners themselves. Evidently he showed uncommon ability as a teacher, for Dr. Barham arranged for his going to London to obtain further instruction at the Royal School of Mines, then domiciled in Jermyn Street. He began this advanced training on Oct. 3, 1859, and he always spoke enthusiastically of the happy days spent at the feet of such distinguished teachers as Percy and Hoffman. Among others, he met and made friends with Robert Hunt, the Keeper of Mining Records, who had shown keen interest in Dr. Barham's plan for giving some scientific training to the mining people of Cornwall. They needed it, to supplement their hereditary instinct in such matters, but they were too little advanced in education to appreciate their necessity.

Richard Pearce studied at the Royal School of Mines for a year, after which he resumed teaching in Cornwall, where he was now well known and cordially supported by the best-educated men in the county. He became familiar with the geologic structure of the mining districts and began to develop ideas as a geologist; for example, he brought forward the suggestion that the tin deposits were essentially zones of metamorphosed granite, and were not of the so-called fissure-vein type. He published an article on the subject in the *Chemical News*, where it caught the attention and expressed approval of Professor Morris, then at London University, by whom he was invited to bring the subject before the Geological Society.

IN 1864 Richard Pearce was asked to work with a commission that was appointed by the government to investigate the health of the miners. Here again he had a chance, of which he availed himself fully, to gain further knowledge. But he was destined for a larger field and a wider opportunity. In 1865 he was asked to go to Swansea, the metallurgical center in South Wales, to erect a plant for the treatment of copper and silver ores. It appears that Williams, Foster & Company, a Cornish firm engaged in the smelting business, were un-



RICHARD PEARCE

able to treat sundry shipments of copper ores and mattes that came from Chile, because they had not the special facilities for the purpose. They had asked Dr. Percy to recommend a man competent for the task, and he had informed them that they need not go outside Cornwall, for Richard Pearce, a former student of his, was qualified for the appointment. The young man explained frankly to J. M. Williams that he lacked experience in smelting, but apparently he inspired such confidence that he was asked to go ahead, after a visit to several smelting works on the continent. He went thither with one of the partners, Richard Bain. First they went to Freiberg, where their inability to speak German was overcome by the kindly interpretation of an American student, famous later as a geologist, S. F. Emmons. Visits to the academy, to the mines, and to the smelters proved most interesting, but it soon appeared evident that the methods of the Freiberg district were not suited to the Chilean shipments; whereupon the two Englishmen proceeded to Mansfeld, still accompanied by Emmons, who, in consequence of a vacation, had the time for such a journey. Many times have I heard both Pearce and Emmons speak of this meeting, which blossomed into a life-long friendship. They were alike in possessing a keen scientific mind, a constant eagerness to learn, and the intellectual honesty to state facts unequivocally. At Eisleben, the center of the Mansfeld copper district, the young scientists met Ziervogel, the inventor of the silver-leaching process that bears his name. At the same time they called upon Augustin, the original inventor of the Ziervogel process, in which the silver ore is roasted with salt to form the chloride, which is then dissolved in a salt solution, the silver from which is precipitated on metallic copper. Ziervogel, as is generally known, improved the process by stopping the roasting of the silver at the sulphate stage, leaving it soluble in hot water before the precipitation on copper plates. Some of us saw the process, many years later, at the Argo smelter, at Denver, of which Richard Pearce became manager. He returned to England, after visits to the Stassfurt salt mines and the picture galleries of Berlin and Paris. Then he built the new plant at Swansea, having as assistant a German, who proved so untrustworthy and insincere that he had to be dismissed. Thirty years afterward this man called at Argo and expressed the hope that the old unpleasantness might be forgotten. This is what Pearce records concerning the incident: "I need hardly say that such a voluntary act on his part was greatly appreciated by me and my heart went out to him." Thus speaks a generous man.

The new smelter at Swansea was completed in the autumn of 1865, the first campaign yielding 3,670 oz. of fine silver from the treatment of an argentiferous matte from Chile, by means of a modification of the Ziervogel process. Some difficulty was found in obtaining silver of a satisfactory fineness, on account of the trouble in separating the last traces of copper from the precipitated spongy silver, but, after a series of experiments, Richard Pearce invented, and patented, a method that corrected the defect; he injected air and steam together into the silver when in contact with water containing sulphuric acid. This method also he adopted later when in Colorado. From November, 1873, to April, 1899, he refined, with this process, 51,151,388 oz. of silver.

TO INDICATE the unscientific character of the metallurgical operations of that day, it may be mentioned that the firm of Williams, Foster & Company, with which Richard Pearce was then associated, owned four smelting plants in the Swansea district. These smelters, with one exception, were managed by men brought from Cornwall, "whose qualification," says our metallurgist, "for such positions were based on their practical acquaintance with mining as practiced in Cornwall at that time; they possessed no knowledge whatever of the art of smelting; they had no knowledge of assaying, nor even of the crude methods for testing ores and slags; in fact, they were guided entirely by rule of thumb and had to depend mainly upon the judgment of their foremen. These were native-born, the Welsh methods of copper smelting having been handed down from father to son, with all the prejudices and antiquated ideas that belonged to the old school." He found it difficult to introduce any improvement that was not Welsh, so eventually he broke up the Welsh clique and replaced them with men from elsewhere, so, he says, as "to have a fair percentage of such men with no knowledge whatever of smelting, but whose business it was to be honest and faithful, and to carry out my instructions." It was difficult for him to get money for making improvements; moreover, the operations of the company were conducted in water-tight compartments, as it were; the accounts were kept in Cornwall; he could not ascertain the costs; the business was not based upon sound principles. Therefore he was discouraged.

In the summer of 1871 a gentleman named William Chambers, of London, was introduced to Richard Pearce at the Swansea works. This visitor was a director of a mining company that was operating in Colorado; his purpose in coming to Swansea was to learn how to treat the ores produced in his company's mines. To him our metallurgist remarked that he would like immensely to visit Colorado, "not dreaming for a moment that there was the remotest prospect of its being realized." A proposal was made there and then that he should accompany Chambers on a journey of inspection to occupy about three months. Permission having been obtained from Williams, Foster & Company, the voyage across the Atlantic was made on the Cunarder "Batavia" in twelve days. Two days were spent in New York, from which train was taken to St. Louis, where the Mississippi was crossed by ferry. West of Kansas City the prairies were alive with buffaloes, the train being actually stopped on one occasion by an obstructing herd. At last they reached Denver, which was then a small town of about five thousand inhabitants. This was just before the boom that started with the discoveries at Leadville. From Denver they went by train to Golden and from there by buggy to Black Hawk, in Gilpin County. The biographic notes refer to the roughness of the road and the serious misgivings aroused during the journey of forty miles in the "spider-like vehicle." Great was the American buggy, before Henry Ford put it out of business!

Upon arrival at Black Hawk, Richard Pearce visited the reduction works of the Boston & Colorado Smelting Company, the manager of which was N. P. Hill, formerly a professor of chemistry in Brown University. He had sent twenty tons of so-called rebellious ore from Gilpin County to Swansea, this shipment being hauled for five hundred miles by ox teams as far as the Missouri River, where it was loaded on a train. The experiments made at Swansea had shown that the ore was susceptible to successful smelting; whereupon a metallurgist named Herman, then in the employ of Vivian & Sons, was brought from Wales to Colorado, it being arranged concurrently that the matte from the plant at Black Hawk should be shipped to Vivian & Sons for treatment at Swansea at a fixed cost. The American capital was provided by a Boston merchant, and thus the Boston & Colorado Smelting Company originated. Herman Beeger, a competent man, took charge of the erection of the plant and later became the superintendent.

To Richard Pearce, in 1871, his visit to Black Hawk was of great interest, of course, because, among other things, it gave him sundry ideas as to the method of smelting that might be adapted to the ores of the mines in the neighboring county of Clear Creek, to which he was about to proceed. He and Chambers went to Empire, passing down Virginia Canyon and through the town of Idaho Springs. At Empire they spent several days in examining the mines, which formed a group known as the Prince Albert, George Peabody, and George Washington silver mines, but they were mere prospects, idle and unpromising. It became obvious that if a smelter were erected the supply of ore would have to come from elsewhere, mainly quartzose silver ores from Georgetown and auriferous copper pyrite from Empire. At that time the high-grade output of Georgetown was being shipped all the way to Liverpool, in default of a local market. A visit to Georgetown followed; and then the two travelers returned to Black Hawk. While there at this time Richard Pearce used his knowledge of mineralogy to good purpose; he detected pitchblende (uranium oxide) on a claim named the Wood in Russel gulch. This is how he describes his discovery:

"IN looking over the old dump my attention was drawn to a beautiful canary yellow coating on the surface of several pieces of mineral which had been exposed to the weather for a few years, and I immediately suspected the presence of uranium, and I was soon able to procure about two hundred pounds of specimens, which I took back to Swansea. After careful selection I sold about one hundred pounds to the firm of Johnson & Matthey, of Hatton Garden, who sent me a cheque for forty-odd pounds, which I converted into American currency and remitted to Colonel Pierson, who was very much surprised to find that one of his properties had furnished such rich material. This was the first discovery of pitchblende on the American continent. A piece of this interesting mineral, recently made famous on account of its radioactive properties, which I picked off the dump at the Wood mine, thirty-four years ago, still shows radioactive properties to a very high degree."

This was written in 1905; and twenty years later, shortly after his 88th birthday, I found that Richard Pearce kept a lump of this very mineral in water in a glass jug, and that he drank the radioactive water twice each day, believing that it ministered to his good health. Was that why the dear man lived to within a month of his 90th birthday?

On the return journey from Denver to New York, Pearce crossed the Missouri at Council Bluffs on a ferry and spent a day in Chicago, two months before the great fire of 1871. On arrival in London, he read his report before a meeting of shareholders at the Cannon Street hotel, which continues recurrently to be the scene of similar somewhat pathetic performances. The report condemned the mining property, but favored the site for a smelter. After the meeting, Richard Pearce returned to Swansea and resumed his regular work, from which

he had been absent for three months. Soon an offer came to him from the company in London to become manager of a proposed smelter in Colorado at a salary much larger than the one he was receiving, and as the Williams-Foster company only made a vague counter promise of increasing his pay, he accepted the proposal to go to the United States. In doing so he was influenced also by the fact that the damp climate of Swansea and the incessant smoke from the copper furnaces had impaired his health, and he looked forward to the clear air of the Rocky Mountain region. So in March, 1872, he sailed from Liverpool, accompanied by his wife and three children.

A REVERBERATORY furnace was built on the site of the old mill at the forks of the creek at Empire and the old crusher was repaired. Soon the little smelting plant was ready for business, and a supply of siliceous silver ore was readily forthcoming, but, unfortunately, the needed proportion of pyritic material was lacking. The smelting practice was to concentrate the gold and silver in a copper matte, which was roasted previous to reduction in a reverberatory furnace. The concentration was in the ratio of eight or ten into one. Lead ores were not available at that time; therefore copper was used to collect the precious metals. The only fuel available was pine wood, to use which the grate area of the fire-box of the furnace had to be decreased, the complete combustion of the gases being aided by a supply of hot air admitted through holes in the roof of the furnace immediately above the fire-bridge. These changes proved beneficial, and the smelting was satisfactory; but the small stock of pyritic ore was soon at an end, and with it the first campaign closed. As a last resource, Richard Pearce decided to produce his own supply of sulphide material, and for that purpose he leased the Marsh mine, in Gilpin County, but this effort proved disappointing, the ore being too lean and the cost of haulage too high. To make matters worse, another English company started a smelter not far down the Clear Creek valley, near the Whale mine, and thereby further decreased the supply of pyritic ore that might have come to the smelter at Empire. Two years later this rival succumbed, but not before it had intensified the difficulties under which Richard Pearce was laboring. He persevered, and made periodical shipments of matte to Swansea, but the high freight rates and excessive charges incidental to the sale of the product in Wales were disheartening.

DURING the summer of 1873 he received a visit from Professor Hill, who came to tell him that his contract with Vivian & Sons had expired and that the firm had declined to renew it on the old terms; whereupon Hill and his friends had decided to try the experiment of treating the matte and separating the constituent metals—gold, silver, and copper—in their own works at Black Hawk. They invited our metallurgist to become superintendent of the new plant, to which the matte produced at Empire could then be sent for treatment. His directors in London approved. Here it may be added that the Empire enterprise survived precariously for two years more, when, by consent of all concerned, it was given its quietus.

"In accepting this new position," Richard Pearce says in his biographic notes, "I felt that I was assuming a great responsibility. The method which I proposed to adopt was new to American soil. The science of metallurgy was little known at that time, and in the general arrangement and construction of the necessary plant, I was limited to whatever the district itself could afford. I found myself obliged from the first to introduce what might well be termed makeshifts." Such is the history of technical operations in remote places; Richard Pearce was successful partly because he was able to adapt his methods to local conditions and to the exigencies of circumstance; moreover, his experience in devising and superintending metallurgical operations when conducted by comparatively ignorant men, such as those whom he had under him at Swansea, taught him to how to take raw labor and train it for the manipulations involved in the running of a furnace. He was essentially a practical man, using that word in its proper sense, of educated common sense. Fortunately for him, also, he received the cordial support and co-operation of his senior associate, Professor Hill, whose friendship is made evident repeatedly in this recital.

The new plant was in action by the end of November, 1873, when the shipment of silver bars created great excitement in the territory, for Colorado did not become a state until three years later. It was a notable event in the history of the young mining industry of the Rocky Mountain region, for it marked the beginning of the separation and refining of the metals on the ground, and the creation of a self-sustaining metallurgical enterprise, relieving the mines of the heavy toll involved previously in the marketing of their unfinished products in Europe.

NOW comfortably established under conditions that gave scope to his metallurgical ingenuity, Richard Pearce made many improvements in the smelting practice at Black Hawk. First he made changes in the construction of the reverberatory furnaces, whereby their capacity was increased 30 per cent at a saving of at least a third of the fuel. "One of the old furnaces was pulled down," he says, "and rebuilt on entirely new lines, special attention being directed to the shape and size of the fire box, and of the supply of hot air over the bridge, which I had found from my experience at Empire to be of great advantage in the burning of wood as fuel in the smelting." As usual, he encountered opposition from the foremen and workmen, but, fortunately, he was supported cordially by Professor Hill, on whose initiative he was presented with $2,500 when the new furnace proved an unqualified success. Next he tackled the problem of separating and refining the gold in the matte and other furnace products. He proceeded to do this in stages, the first being the concentration of the gold in the form of a rich alloy, known as "gold bottoms," then the cleaning of this product in a suitable furnace and the converting of it into a hollow shell-like material by granulation in water; the third stage was the oxidation of the copper in the granulated gold alloy, which later went into a Chilean mill, after which the copper was dissolved with sulphuric acid in suitable vats, leaving a gold residue, ready to be melted and refined.

Among the difficulties to be faced was the high cost of sulphuric acid, which had to be brought thither from St. Louis, and, secondly, the heavy freight charges on the resultant copper sulphate, which had to be marketed in the Eastern states. Thereupon it was decided to erect a small plant at Boston for the acid treatment, and to complete the operations there, leaving to Black Hawk only the preparation of the alloy together with the oxidation and grinding of the granulated products. This plan was followed for one year, when it was

discontinued, for several reasons, one being the difficulty in agreeing upon the assays. The product as shipped from Colorado contained about 600 oz. of gold per ton, the value therefore being $12,000 per ton in gold alone. Our metallurgist made a number of experiments to ascertain if the refining at Boston could not be obviated, and he did this without the knowledge of Professor Hill, who learned of it only when a successful result had been achieved, in the shape of a lump of gold weighing three pounds. "I took this specimen of my handiwork," he says, "to Professor Hill's office, and handed it to him. His first enquiry was, 'Where did this come from?' I then explained how it was produced. His next question was, 'Can you produce it on a large scale?' My reply was, 'Yes, and I will promise to ship a bar of a thousand ounces next week.'" Thereupon a telegram was sent to Boston instructing the staff to close their refinery. In the next thirty years, to October, 1905, no less than 45 tons of gold was separated and refined at Black Hawk and, later, at Argo, by this process as devised by Richard Pearce. Forty-five tons of gold is equivalent to $27,000,000. The details of the process were kept secret for a long time, because until the electrolytic separation of gold from copper came into vogue it was the method best adapted to the metallurgic conditions of the West. Many were the guesses made as to the details of the secret process, and technical literature contains the fantastic imaginations of sundry writers on this intriguing subject. The actual simplicity of the process balked most of the quidnuncs, from Thomas Egleston to Roberts Austen.

THE plant at Boston continued to be used for the manufacture of bluestone from the Black Hawk residue; and the operations at Black Hawk yielded gold bars 900 to 903 fine and silver bars 999.5 fine, both of the precious metals being sold to the mint. It is equally worthy of remark that at this time, in 1876, the directors of the company in Boston decided that the staff in Colorado should receive a share of the profits, in lieu of salary, and this arrangement was continued during the life of the enterprise, to the mutual advantage of all concerned.

Meanwhile the scarcity of fuel, which was wood, was rendering it advisable to change the site of the smelting operations. The coalfields of Trinidad, El Moro, and Canyon City had been developed rapidly and successfully, so that a large supply of good coal was available in Colorado. A trial of the coal was made in one of the furnaces at Black Hawk, and it proved satisfactory. Another reason for a change of site was forthcoming when, in the autumn of 1876, W. A. Clark, of Montana, came to see the works at Black Hawk and then arranged to send consignments of ore from his Original mine at Butte. He shipped large quantities of this copper-silver ore despite a freight rate of $40 per ton. The ore consisted mainly of oxidized material, rich in silver, together with copper carbonate. The average assay was 250 oz. silver per ton and from 15 to 20 per cent of copper. No smelting was being done in Montana at that time, and the ore had proved unsuited to amalgamation.

AT this time also the discoveries at Leadville promised further supplies of ore; therefore in the spring of 1878 Messrs. Hill and Pearce purchased a site for their new smelter at a locality two miles from the city of Denver to which the name of Argo was given. In November and in the early part of 1879 the entire business of the company was transferred to the new plant. The capital of the company was increased to provide for the expansion of the business. This grew so fast that soon it became desirable to erect a branch smelter at Butte, whereupon a subsidiary company, the Colorado & Montana Smelting Company, was formed, the working capital of $100,000 being provided in equal shares by N. P. Hill, W. A. Clark, Henry A. Wolcott, and Richard Pearce. The local manager was Henry Williams, he being promised a fifth of the capital in case he made a success of the enterprise. The plant was erected in the summer of 1879. It is almost amusing to note how quickly these smelters were built, and how little money was needed to build them, as against the time and capital necessary to build the enormous plants that constitute a metallurgic unit today.

The Butte smelter was a success from the start, and duly provided matte for the Argo works. As the business developed, it proved desirable to acquire mining properties in the Butte district, the most important of those purchased being the Nettie, Gagnon, and Original Butte. To do this the company had to be reorganized, becoming the Colorado Smelting & Mining Company. In 1879 Professor Hill was elected Senator from Colorado, and the business part of the management was placed in the hands of Henry Wolcott. Meanwhile, Richard Pearce was developing the metallurgic department by doubling the capacity of the reverberatory furnaces—that is, from 12 tons to 24 tons of ore per day. Moreover, the rich ore from Leadville contained a good deal of silver as chloride, which suffered loss owing to the high temperature of the furnace; after laboratory investigation, a remedy was found in the roasting of such ore in admixture with iron pyrite, the union of the silver with the chlorine being broken by the greater affinity of the silver for the sulphur, the result being that the chlorine was driven off and the subsequent loss in the smelting was reduced to the normal. The discovery enabled the Argo plant to compete on favorable terms with the other smelters, which still suffered loss from this cause.

RICHARD PEARCE lived in Denver with his family, which included, besides his wife and daughter, four sons, three of whom followed in his footsteps as metallurgists or mining engineers. In 1885 he was appointed British Vice-Consul, for he never became an American citizen. Other honors, however, came to him in due course; in 1890 he received the honorary degree of Ph.D. from Columbia University, and in the same year he was elected president of the American Institute of Mining Engineers. Before that he had been twice president of the Colorado Scientific Society, with which he was closely identified and to the proceedings of which he contributed a number of valuable papers dealing with geology and mineralogy. He was a keen mineralogist, and it is fitting that his memory should be perpetuated by a mineral to which his name was given—namely, pearceite, a sulphide of silver and arsenic, first found at Aspen, Colo. Owing to his knowledge of tin ores, he was consulted frequently in regard to supposed finds of tinstone in Colorado, and usually was able not only to recognize the mineral as cassiterite, but also to state the name of the particular mine in Cornwall from which it came, for many of these supposed tin prospects were "salted" with imported mineral. Once a tin-mining fraud was exposed by him when he leached an ore free from the soluble tin chloride with which the specimens

had been impregnated. He had mining interests outside his smelting companies; for example, he was a large shareholder in the Smuggler-Union mine, at Telluride, in the San Juan region of Colorado. However, his main preoccupation was scientific rather than financial; he was keenly alive to the vagaries of ore deposition and contributed many valuable observations to the literature of the subject; moreover, he took a warm interest in the work of his friends, not only of the older men, of achieved reputation, such as Emmons and Whitman Cross, but of the younger fellows, to whom encouragement from him meant a good deal. Here I venture to record my gratitude to Richard Pearce for his kindness and sympathetic encouragement to me more than thirty years ago. He retained his status as fellow of the Geological Society and of the Mineralogical Society, both of London, as long as he lived. He was a life member of the Royal Institution of Cornwall, maintaining thereby a link with the "old county" and his friends there.

IN 1902 Richard Pearce retired as manager of the Argo smelter and returned to Cornwall, where in 1908 he associated himself with Williams, Harvey & Company in building a tin smelter at Bootle, near Liverpool. This smelter, thanks partly to the growing production of tin in Nigeria and Bolivia, proved a success both technically and financially; it kept him in pleasant professional activity for several years, until, leaving the works in charge of his son Frank, he changed his residence to London, in 1919. For the rest of his life he lived in Kensington, not far from the museums and science schools, in which he continued to take a lively interest. In 1908 he was president of the Royal Institution of Cornwall and delivered an address on early smelting operations in Cornwall. He received the gold medal of this society in 1909; and in 1925, at the age of 88, he was awarded the gold medal of the Institution of Mining and Metallurgy, "in recognition of the services which he had for so long rendered to the advancement of metallurgical science and practice," as the president, Sir Thomas Holland, stated on the occasion of the award. The recipient responded in simple words, expressing his thanks. That was his last public appearance.

Richard Pearce lived so long that he outlived the reputation he had won among his contemporaries, and to the young men—two generations after him—he had become a part of an honorable tradition at the time when the announcement of the award of the Institution's medal reminded them that he was still among the living. To those who knew him in Colorado and Montana in the days of his active career, he stood, like James Douglas, for all that was honorable and sagacious in the work of our profession. He had a true scientific mind, a cooperative spirit, a generous disposition, and to these he added the innate courtesy of a gentleman. He is now one of the worthies in the history of mining.

POSTSCRIPT. Richard Pearce died on May 18, 1927. The directors of the American Institute of Mining and Metallurgical Engineers passed the following resolution:

Resolved, that in the death of Richard Pearce, past president, this Institute has lost a valued member and Metallurgy one who conferred marked distinction on the art.

An Englishman, he pioneered in America and contributed greatly to the foundations upon which our modern smelting industry stands.

Returning to his homeland he carried with him the love and affection of his many professional friends and did much to build up the ties that bind especially close the professional men of the Anglo-Saxon countries.

Able, sincere, and generous, his business and professional career affords an example worthy the widest emulation.

Accident Prevention at Moctezuma Copper Property

MOCTEZUMA Copper, at Pilares, Sonora, Mexico, is making a noteworthy record in the prevention of accidents, according to a recent circular of the U. S. Bureau of Mines, by E. D. Gardner, supervising engineer, Southwest Experiment Station, Tuscon, Arizona.

In connection with an intensive educational campaign and systematic inspection many safety measures have been adopted. Almost all work at the mine is done under contract. Even hoist engineers are employed under this system. Each stope or development face is given to a contractor, who hires his own men with the approval of the foreman. Each division foreman gives the contracts and sets the unit rate for the work done for his part of the mine, based on the standard wage scale.

In 1925, 3 fatalities and 275 lost-time accidents occurred. During that year a concerted effort was started to reduce the number of accidents; in 1926 there were 4 fatalities and 78 lost-time accidents. Twenty-seven of these accidents caused more than two weeks and 51 less than two weeks' lost time. Although the fatalities increased by 1, the total number of accidents was less than a third of the number for 1925. A total of 428,905 shifts was worked in 1926. Seven accidents, including one fatality, occurred in January, 1927; one accident in February; none in March, and one in April. The total number of accidents for 1927 was only a little more than half the number for 1926. No lost-time accidents occurred at the concentrating plant for over three years.

Accidents from falls of rock are the most frequent in this mine; however, the rate has been greatly reduced by supervising the contractors more closely and requiring them to safeguard their workers by teaching them safe methods and the use of available safe equipment and devices.

Men on stope contracts are paid by the number of cars taken from the stope or for the cubic meters of ground broken. In addition, they are paid a contract price for placing cribs or stulls for supporting the back, as well as for building chutes, sorting ore, and other necessary operations looking to safety and efficiency. The facts that the company pays for work done to make the stopes safe and that time thus spent does not reduce the contractor's earnings are decidedly important in preventing accidents from falls of roof in the stopes of this mine. In this manner much of the objection to the contract system as to its effect on safety is overcome; in fact, under the system in vogue in this mine, the individual worker is paid extra to enhance his own safety and that of fellow workers.

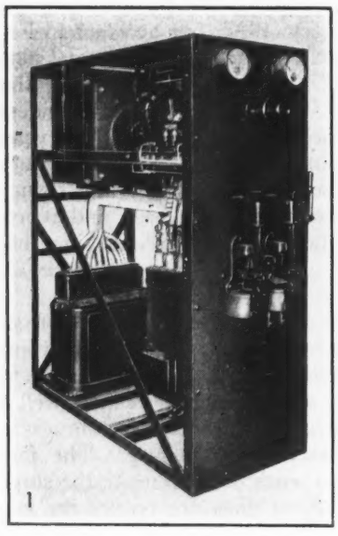
The achievement in safety at the Moctezuma mine proves that accident rates can be held to a minimum when an intelligent and concerted effort is made to do so. Also it would appear that the class of labor employed does not have an important bearing on the frequency of the accidents and that excellent safety records can be obtained under the contract system of paying for work done, provided the contract system includes pay for safety work as well as for work in connection with production.

Electric Equipment for Power Shovels

By DAVID STOETZEL
Industrial Engineering Department, General Electric Company

IN THE LAST FIVE YEARS the General Electric Company has built and put into successful operation approximately 500 electric-shovel equipments of all sizes, ranging from the large Ward Leonard equipment for the 8-cu.yd. coal strippers down to the rheostatic-control equipment used on gas-electric machines for grading and paving work. It is evident that there is a great and growing trend toward the use of electric power for the operation of shovels, and the interest manifested in the general subject by all classes of operators warrants a discussion of some of the principal features of the typical equipment.

Although power shovels may be divided into classes and types in various ways, the general requirements of the service are the same, and, with a few minor exceptions, the special features required in the electric equipment will be the same for all classes and types. On some of the larger models a number of refinements and auxiliaries, such as electrically operated dipper trip, foot-operated controllers, lower frame lighting transformer, and other complementary devices, may be included, as these items represent only a small fraction of the total investment. On some of the smaller models these non-essentials must be omitted, as the advantage to be gained by their use does not warrant the extra expense involved.



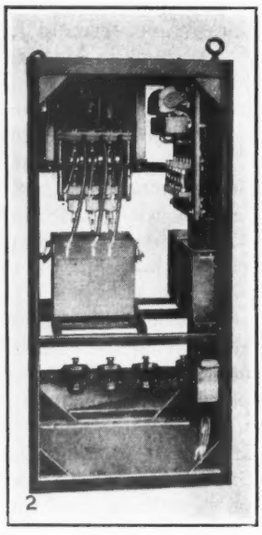


Fig. 1—Steel-front switchboard panel for controlling synchronous motor of shovel motor-generator set. Fig. 2—Steel inclosure for miscellaneous alternating- and direct-current control units, cut-outs and main-line contactor for throwing induction motor of motor-generator set directly on the line. The doors are not shown.

Some models afford ample space for motors, motor-generator set, control cabinet, and other apparatus, whereas others have very little space available and both the electrical and mechanical parts must be designed to minimum dimensions. However, in all cases there is the necessity for the same characteristics of sturdiness, reliability, excess capacity, simplicity of operation, ease of maintenance, and ability to function successfully and continuously under all sorts of adverse conditions.

SHOVEL APPARATUS OF DISTINCT TYPE

A consideration of the conditions under which shovel equipment must operate makes it apparent that many features not found in the standard types of apparatus are necessary to meet this service successfully. In fact, these special features have become so numerous and so vital in the design that, in a measure, we have come to regard shovel motors, resistors, generators, and other equipment not as modifications of standard designs, but as separate and distinct types designed in all details for this particular service. In other applications where extreme sturdiness and reliability are desired, we give consideration to the use of "shovel-type" apparatus.

Most *Engineering & Mining Journal* readers are undoubtedly sufficiently familiar with the conditions under which shovel equipment operates. There is no need, therefore, to describe in detail the jolting, shock, vibration, tilting, climatic, weather, dust, and moisture conditions and the frequent lack of adequate maintenance met in this service, or to explain the necessity for exceptional reliability, power, and sturdiness in all parts of the equipment. However, the general features, as well as the details of the electric equipment with relation to these conditions, are very interesting.

In every respect, direct-current equipment with mill-type, heavy-duty motors is best adapted to meet these conditions, and generator voltage control is greatly favored because of the simplification of small electrical and mechanical parts that it makes possible. Other systems—particularly the rheostatic type using drum-type controllers and a motor-generator set with a single generator having modified Ward Leonard characteristics as used extensively and successively on smaller shovels—can be built to meet shovel service conditions with a considerable degree of success, but there is no other system at a reasonable cost which is comparable with the Ward Leonard on the basis of performance, durability, and reliability.

A consideration of the individual items of equipment for a modern electric-shovel installation will show the large number of special features involved and will give an indication of the amount of developmental work and field experience that has been necessary to bring the electric shovel up to its present state of refinement and efficiency.

Where necessary to step down the power-line voltage, standard type and arrangement of power transformers may be used. These should be of ample capacity to guard against excessive voltage drop in the line. It is highly desirable from the standpoint of safety that the secondary which supplies power to the shovel be a circuit with a solidly grounded neutral. It is advisable to include the standard switching apparatus, fuses, and lightning-arrester equipment with the transformer bank, particularly if the transmission line running out to the location of the transformers is a long one with a lot of power behind it. If the transformer equipment is not of the outdoor type, substantial housing to protect it from the weather must be provided.

The Trailing Cable

The trailing cable may take off directly from the transformers, or, as is more generally the practice, a short pole line may be run from the transformers out into the mine or quarry. In any event, the trailing cable should be equipped with a disconnecting switch of some sort at the power-line end, to provide a means of entirely disconnecting the shovel and cable from the power supply if it becomes necessary to do any work on or near the electrical parts.

Experience has shown that cable with heavy, high-grade rubber armor will give the longest and most satisfactory service. Marlin or jute armor was formerly used to a considerable extent and steel-wire armor to a lesser degree. Neither of these types is as tough or wear-resisting as the rubber-tire type, and both have the further disadvantage that a break at a single point will cause the armor for a considerable distance along the cable to loosen and unwind unless a repair is made immediately. It is impracticable to make a cable of this type with the conductors solidly embedded in the rubber, as the spacing between conductors cannot be kept uniform. Hence, it is necessary to make each conductor separately, with the correct amount of insulating rubber around it, then combine the required number of conductors with suitable filler material, and afterward put the armor over the whole assembly. On account of the harmful effect of corona on the rubber armor, for voltages of 2,300 and above it is advisable to use a sheathing of fine copper gauze over each individual conductor and its insulating rubber. This gauze must be solidly grounded at both ends of the cable to secure the desired protective effect. If properly designed, it may also serve as the ground conductor for the shovel cable. In general, for three-phase circuits, the cable will be three-conductor type, using the sheathing as the fourth or ground conductor.

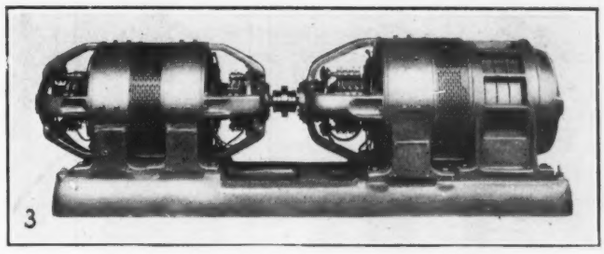


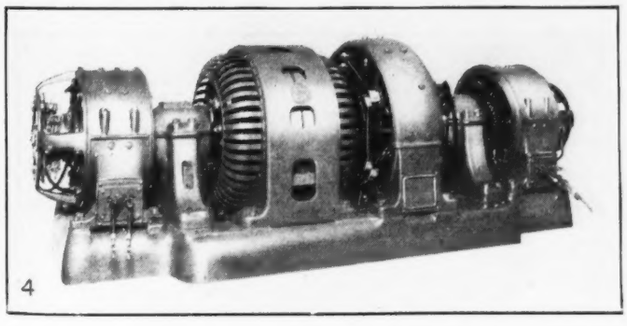
Fig. 3—Four-unit, ball-bearing motor-generator set for small revolving shovel

If sheathing is not used, a four-conductor cable will be necessary. The ground conductor is securely attached to the shovel frame at one end of the cable and to a dependable ground connection at the other end. The length of the cable will vary from 250 to 1,000 ft., depending on the nature of the shovel operations. The average length used is about 500 ft. This gives a fairly good range of operation and still is not unwieldy.

Cable Reel Sometimes Used—The Slip Rings

Sometimes, particularly when a long cable is used and frequent moves are made, a shovel is equipped with a cable reel. This may be motor- or hand-operated, but the hand-operated type is more often used, as the operation is infrequent and the first cost of the motor-operated type is comparatively high. The cable reel consists of a large drum on which the cable is wound or from which it is paid out as the shovel retreats or advances. Suitable slip rings or current collectors are built inside the drum to transfer the power from the moving to the stationary element.

On railroad-type shovels where the part of the shovels containing the electric apparatus does not swing with respect to the part resting on the ground, the power lines run from the cable reel—or, if no cable reel is used, from the point where the trailing cable comes into the shovel—directly to the disconnecting switches. In revolving shovels, a set of slip rings must be built about the center of rotation to transfer the power from the stationary to the revolving part of the machine. In general, these slip rings are similar to those used on large induction motors, and use brushes to collect the current from



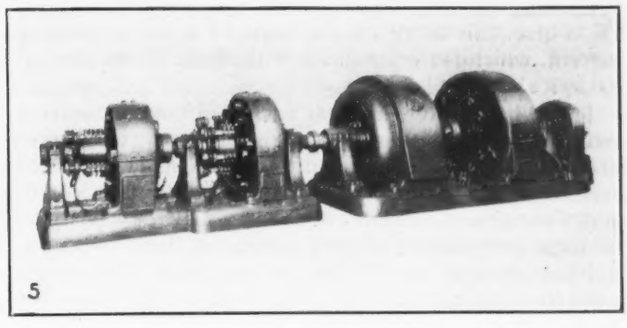


Fig. 4—Four unit, two-bearing, motor-generator set for 4-cu.yd. shovel. Fig. 5—Five-unit motor-generator set for large electric shovel

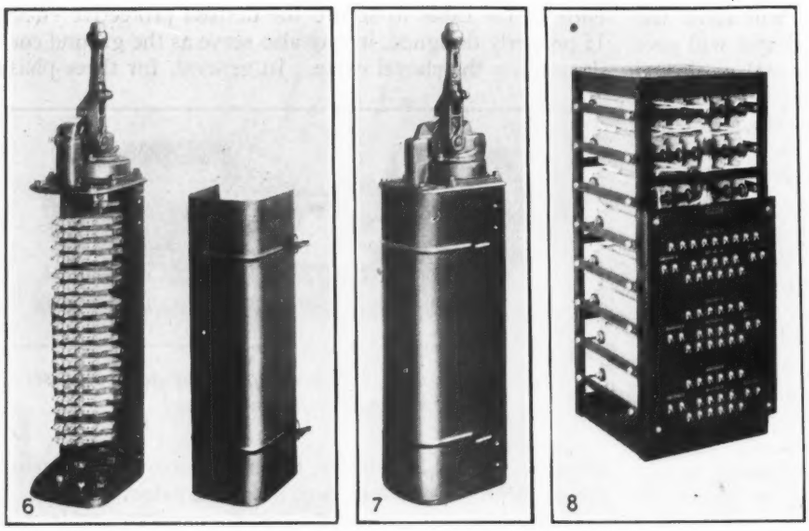


Fig. 6—Typical shovel controller, cover removed. Fig. 7—Typical shovel controller, cover in place. Fig. 8—Resistor bank including all field resistors necessary for Ward Leonard shovel control.

the rings. As the speed is very low, high brush pressures and large-diameter rings can be used. The most important feature in the design of slip rings for use on shovels is to see that they are thoroughly protected from dust, dirt, and moisture, and, also, that they are located where they will not be damaged by accidental contact.

Disconnecting Switches and the Switchboard

Once inside the shovel cab, the power is brought to a set of disconnecting switches which make it possible to disconnect the switchboard and other equipment entirely from the line, if any work has to be done. It is desirable to have these disconnecting switches or primary cutouts of a type that will include protection against short-circuits in the electrical apparatus. Almost any of the standard disconnecting, fused-type, primary cutouts on the market may be used. The main requirements are that they be inexpensive, protected, compact, and have an easily renewable fuse element.

The next element of the equipment, following the progress of the current from power line to shovel motion, is the switching equipment for controlling the alternating-current motor on the motor-generator set. Of course, this is all on the basis of using alternating current, which is the condition with about 99 per cent of modern shovels.

The switchboard equipment for the alternating current end of the motor-generator set must be as compact as possible, and various special features must be incorporated to overcome troubles incident to the severe operating conditions encountered. Meters are omitted wherever possible. In most installations exciter voltmeter, line voltmeter, and line ammeter are all that are required. Even these are often omitted and suitable provision is made for correct adjustment at the time of setting up the shovel, after which no further attention to such details on the part of the operator will be required.

The construction of the switchboard structure must provide extra bracing and supports to withstand vibration and shocks. Oil tanks, when used in connection with high-voltage switches, must have features to prevent oil spillage caused by tilting and rolling.

Fig. 1 shows a dead front type switchboard for use on a large shovel. This incorporates hand operated oil circuit breakers. A somewhat different type of switching equipment is shown in Fig. 2. This is a steel inclosure with high-voltage contactor for controlling the induction motor on a motor-generator set, the motor of which is thrown directly across the line for starting. This type of cabinet includes not only the control equipment for the alternating-current motor, but also field rheostats, lighting transformer, cutouts, and direct-current contactors for controlling the exciter circuit and solenoid brakes. In effect, all of the small miscellaneous parts of the equipment have been consolidated and grouped together in this steel cabinet. Both the alternating- and direct-current contactors are controlled by means of push-button stations located at the operator's hand.

The tendency at present is toward the use of steel-cabinet type construction for all of the switchboard and control equipment aboard the shovel. This type of construction can be made to include all the necessary featurse of resistance to vibration and hard usage and at the same time can be assembled as a unit at the factory and put on the shovel with a minimum of time and expense.

On shovels using alternating current exceeding 550 volts and having a motor-generator set for converting the alternating-current power to direct current, it is

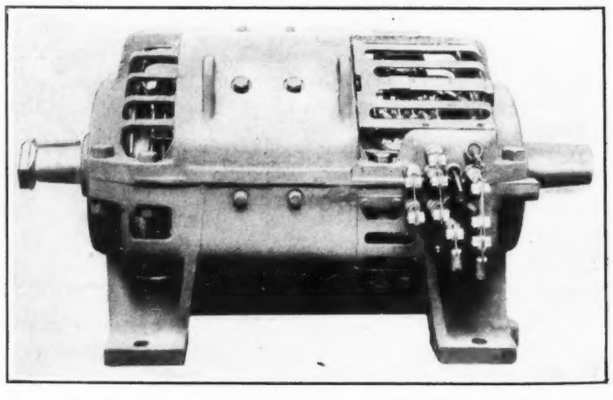


Fig. 9—Typical mill-type motor for shovel service, equipped with roller bearings and built-in fan.

usual to make use of a bank of small transformers, or one 3-phase transformer, for supplying low voltage for lighting and for driving the air compressor, exciter motor-generator set, dipper trip, and various auxiliaries

such as an oil pump, heaters and blowers. On some of the smaller shovels these non-essentials are omitted and lighting and air compressor power is taken directly from the exciter, if Ward Leonard control is used, or from the main generator if rheostatic control is used.

In general, transformers for shovel service must be oil-tight to prevent oil being splashed out over other parts of the equipment, such as the windings of the motors and generators. Furthermore, loss of oil would invite burn-out or flash-over in the transformer itself. To accomplish the desired result, not only the transformer cover must be an oil-tight job, but all the leads and bushings must be designed to prevent the passage of oil. The oil-tight features of the cover must be of such a nature that they will not interfere with quick removal and replacement of this part in case inspection is necessary.

The latest shovel-type transformers have a case fabricated of steel plate by means of electric welding. The bushings are of a special oil-tight type. Cover and gaskets, together with provision for fastening, are all specially designed for this service.

Shovel Motor-Generator Sets Compact

Physically, shovel motor-generator sets are characterized by very compact construction with a view to keeping the length as short as possible; extra shafts and bearings, to prevent the distorting effects of vibration; and simplicity and sturdiness of brush holders, connections, and similar parts, to withstand rough usage at the hands of unskilled operators. Figs. 3, 4, and 5 show various types of shovel sets. For all the small- and medium-sized

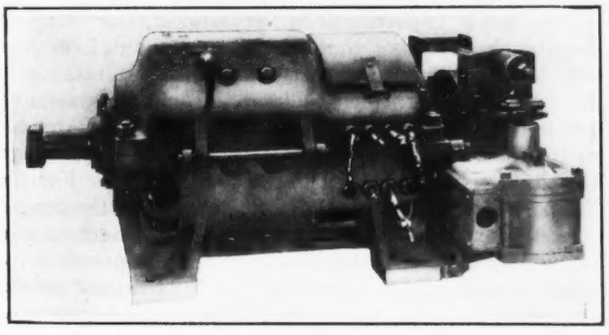


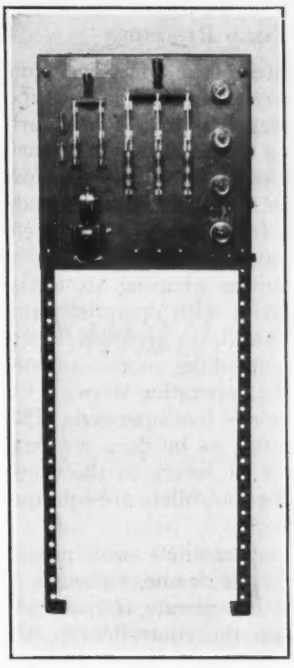
Fig. 10—Protected type mill motor with motor-mounted, spring-set solenoid brake.

machines it is necessary to keep the length to a minimum; it is a great advantage if this does not exceed 10 ft. (the maximum shipping width with set mounted crosswise of shovel), as it is then possible to ship the shovel upper frame without removing the motor-generator set.

In many instances, to save length, only two bearings are used on a set consisting of four machines: the driving motor and the three generators, one for each motion. With a four-unit set of this type, a small, separate motor-generator set is used for supplying excitation for all of the machines.

The use of ball bearings on shovel motor-generator sets is coming rapidly to the fore. A double purpose is accomplished: the length along the shaft is shortened considerably and difficulties due to oil leakage are obviated. Sleeve bearings of standard design present innumerable difficulties in shovel operation caused by oil leakage and consequent damage. Though oil leakage can be obviated by designing sleeve bearings with special features to guard against this, particularly under conditions of vibration and tilting, the use of anti-friction bearings solves the problem more effectively and simply. Another point which can be easily taken care of in this design is the elimination of end play without the use of special parts and adjustments.

Electrically, the motor-generator set, both the driving



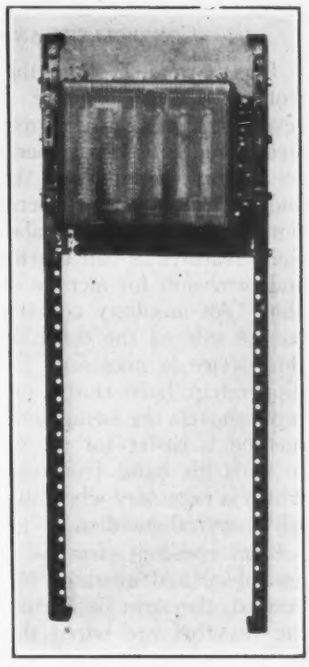


Fig. 11—Dipper trip control panel, front view. Fig. 12—Dipper trip control panel, rear view, showing permanent resistor.

motor and the generators themselves, must have tremendous overload carrying ability. High current and torque peaks must be successfully withstood, as these are encountered in everyday operation and the high equivalent heating effect of some periods of operation makes it necessary that the machines be designed with a high continuous overload capacity.

Generators for Ward Leonard control will have the special field windings consisting of separately excited, self-excited, and differential-series fields to give the special volt-ampere characteristics peculiar to this system as applied on shovels. The general tendency on motor-generator sets is toward the use of induction motors on the smaller shovels and synchronous motors on the larger ones. Of course, special conditions may affect this practice considerably. With synchronous-motor installation it is the usual practice to use an 80-per-cent power factor motor, which will provide a field strength sufficient to give approximately unity power factor at the maximum load. This also gives the motor the ability to produce extremely high pull-out torque and successfully to meet wide variations in line voltage. Induction motors do not have this advantage and should not be used with a power line where the voltage will fall more than 10 per cent below normal.

The exciter set is usually a small, separate, two-unit motor-generator set for supplying excitation to all motors and generators. This set should be equipped with ball bearings, and the driving motor may be of the squirrel-cage type suitable for starting directly across the

line. The generator should be of the compound-wound type, self-excited, with the best possible regulation.

In case there is sufficient room on the shovel, a direct-connected exciter on the main motor-generator set may be used. This will have the same characteristics as the separate set. A usual power supply for excitation is 125 volts, although 250 volts may be used on large equipments to reduce the current.

Controllers and Field Resistors

Figs. 6 and 7 show the latest type of shovel controller. Controllers are always of the drum type, reversing, with vertical operating handles. Particularly strong and substantial operating mechanism is necessary, on account of the rough treatment these devices receive and the frequency of operation. Under average conditions controllers make about four operations a cycle. Such features as ball bearings at points of greatest wear and provision for alemite or similar greasing are advisable. An auxiliary contact device with operating latch on the side of the controller handle is provided where this device is necessary for controlling motor-operated dipper trip, hoist clutch, or other operating device. On some shovels the swing controller is foot-operated. This method is easier for the operator, as he does not have to shift his hand from one set of levers to the other, which is necessary when all three controllers are equipped with vertical handles.

The resistors for all three motions are usually assembled and mounted in a single frame, although, if desired, they can be furnished in separate frames. As the resistors are wired through the controllers to the various generator and motor fields, it is advisable to locate them as near as possible to the controllers and still have them readily accessible for inspection, adjustment, and repairs. Fig. 8 shows one of these combined resistors. It will be noted that a terminal board on the front provides for connections to the field and controller terminals. There are also terminals at tap points on the generator's separately excited field resistor, to provide for easy field adjustment of the maximum current point. Wire-wound units on compound forms are used, as these are especially suitable for withstanding vibrational and climatic conditions.

Direct-Current Driving Motors

The heart of the electric-shovel equipment is the direct-current driving motor which, through suitable mechanical parts, actuates the various shovel motions. The motors used are of the mill type—that is, the heavy-duty, low-inertia motors originally designed for steel-mill auxiliary service. They have roller bearings of exceptionally large capacity. Frames are constructed of cast steel, to give easy access for repairs and replacements. Commutating poles are used on all sizes. Class B insulation, heat-resisting, consisting of mica, asbestos, and varnish compound, is used throughout. This permits rating these motors for 75 deg. C. rise, and a total observable temperature of 115 deg. C. may be obtained without detrimental effect to the insulation or other parts of the motor. All motors are fitted with fans to secure the advantage of ventilation and thus provide higher continuous rating. In extreme cases auxiliary blower equipment may be fitted to increase the capacity still further. Figs. 9 and 10 show open and semi-inclosed types of motors.

To lighten the labor of the single operator, practically all large and medium-sized revolving shovels, and many of the smaller ones, have a motor-operated dipper trip mechanism as an optional feature. This consists of a small, totally inclosed motor mounted at the front end of the cab or on the dipper stick, depending on the design of the mechanism as used by different manufacturers. If located on the dipper stick, it operates through a geared crank and chain mechanism so arranged that, as the motor revolves, it gives successive tugs at the chain attached to the trip latch. The arrangement is such that, when power is not applied to the motor and the dipper is lowered into the pit at the start of digging, the latch will return to place and hold the dipper door closed. Either alternating-current, squarrel-cage, induction motors, or direct-current, compound-wound motors can be used with this arrangement. If located at the front end of the cab, the motor is fitted with a comparatively large pulley or reel, to which is attached a small rope running up the boom and out to the latch mechanism. In this arrangement power is kept continuously on the motor through a high resistance, thereby providing a small amount of torque just sufficient to reel in the slack or pay out as the dipper moves through the cycle. When it is desired to trip, the resistor is short-circuited, putting full voltage on the motor and causing a strong pull on the rope. The dipper door closes and the latch returns to the locking position by the action of gravity when the dipper is brought to the proper position in the pit. With this arrangement a direct-current motor is customarily used, as it is better suited to withstand the conditions requiring continuous low torque at standstill. Fig. 11 and 12 show a typical dipper trip panel.

Dipper Control, Brakes and Magnet Valves

The dipper trip control is very simple, consisting of line switch, contactor controller from the auxiliary contact device on one of the controllers, and a resistor in the case of the scheme requiring a continuous reduced torque. In the one case the contactor throws the motor on the line; in the other, it short-circuits the resistance. Usually a relay is added to protect the motor. For the alternating-current motor thrown directly on the line, it is a thermal overload relay. For the direct-current torque motor, it is a time-limit relay which prevents the motor from keeping on the line for more than one second continuously. The resistor is of the inclosed, protected type using vibration-proof resistance units.

Spring-set, shunt-wound, solenoid brakes for operation from the 125-volt exciter circuit may be used with any of the mill motors. These are controlled by the controllers for the various motions through contactors. The coils and mechanical construction of these brakes are suitable for withstanding vibration, and the mechanical features are such that the brakes will operate positively under all conditions of tilting and shocks.

As an alternative to using solenoid brakes, air-operated brakes, controlled by small magnetically operated air valves, may be used. With this equipment a standard, industrial-type, reciprocating air compressor is used for supplying the air to operate the brakes. Automatic governor and starting equipment are included. The pressure varies between 90 and 125 lb. For a medium-sized shovel approximately 25 cu.ft. of free air a minute is required as the compressor capacity. The magnet valves which control the admission of air to the brake-operating cylinders are of the same type as used for railway work and are controlled from suitable fingers in the controllers.

From the foregoing it will be seen that practically every piece of electric equipment on the modern shovel has been designed with special features to make it better fitted to give long and satisfactory service with a minimum of maintenance. The electric shovels now being produced are far in advance of their predecessors of only a few years ago in all of the operating and construction features which make for large output, uninterrupted service, and low maintenance cost. Isolated instances may be found where electric shovels have not given a good account of themselves, but such are rare indeed, and the trouble can nearly always be traced to some special local condition, such as lack of ordinary care in regard to lubrication, poor power supply, prejudiced or unskilled operator, or other unfavorable factors. Apparatus being produced at the present time is designed to give satisfactory service even under severe handicaps of the nature mentioned.

Observations, Serious and Not So Serious,

On the Use of

The Lathe at a Small Mine

By W. H. M. WATSON

Assistant Manager, Santa Cruz Mining Company, Santiago Papasquiaro, Durango, Mexico

SOME PEOPLE—I sometimes call mining men people, but in my opinion they more or less seem to be a different species—will probably think that what I am going to propose is an absurd and simple idea; one that anyone ought to think of. I have found that the more simple an idea is, the harder it is to think of.

Now I have been at quite a number of mines in my time, visiting and so on. Never have I seen a lathe at a mine. If you happen to have one, turn the pages and read the stock market or the positions vacant; but if you haven't a lathe, you'd better stick around. I suppose that there are several lathes in use in mines; but I have not seen or heard of any of them.

Some readers—if there are any readers of this—will probably think this sort of machine suitable for a small mine; others will think it suited for a large mine. I think that a lathe would be one of the best investments possible for any sort of a mine and mill. The further away the plant is from the railroad, the more valuable it will be to the owners. And a lathe can be transported across any trail over which a mule can go.

A lathe is not, contrary to all the talk you have possibly heard, hard to operate. Lathes are not expensive, and the things that can be made on a lathe are without number.

I'll tell you about our experience, then perhaps you can draw your own conclusions. First. let me assure you that I am not advertising anybody's lathe. There are lots of good ones on the market. I suppose a great many bad ones too. I don't know.

No mine, no matter whether large or small, keeps an absolutely full line of repair and spare parts. If yours does, then pass on and look at the pictures on the next page; if there aren't any there, then look at the funny paper, for you haven't any worries anyway.

At this mine, we are quite a number of days from the nearest railroad. Everything is brought out on mule-back. Quite often some mishap has caused the mine or mill to be practically inoperative for some time, while the mechanic fashions a repair part to work until the new one arrives. The arrival takes from a month to three months. Production is of course lowered in this time, and sometimes it is nil if the mine or mill is forced to stop. You never can tell what is going to pass out next.

About two years and a half ago the manager had a really intelligent idea—ideas with managers are like ideas with women: hard to define—that a lathe would be useful here. We got in touch with a firm in Monterey and purchased a German-made lathe—and a large one. It cost $750; that's all. A concrete foundation was built here before its arrival, but when it arrived it was found that the weight of the lathe did not necessitate having it screwed down, so it still stands on the concrete loose, and although we have made some very large pieces on it, it has never moved.

When this lathe arrived, no one here knew the first thing about it, but we finally got it going. Then a small 3-hp. gasoline engine, of John Deere make, arrived and this we belted to the lathe. It's easy to start and inexpensive. Now we were ready to see what there was to see.

GETTING ACQUAINTED

If I don't stop saying we, you readers are going to think that I'm Charles Lindbergh, or his shadow. The instruction books were read, all the literature was carefully gone over, and away we went. By careful and slow going at first and watching our step, we soon had the upper hand on the outfit and knew its secrets.

Today this lathe is as good as new, never had anything wrong with it, and man! man! the money we have saved in doing away with shutdowns and other losses!

I'm going to tell you of some of the things we make on this lathe, the amount of time it takes a novice like myself to make them, and what it costs us.

In our flotation we have several small lifting pumps, the shafts, glands and other parts of which insist on wearing out quite regular-like. A new shaft is made for the pump in 30 to 45 min., depending on what size

shafting is placed in the lathe to be cut down. The cost of gasoline, material and all, for the making of this shaft, usually amounts to about 50c.; sometimes as much as $1. The shaft is sold in the States by the pump company for several dollars, and we don't have to pay freight, either. A broken bolt, even a mean-looking difficult bolt with a shoulder or several shoulders on it, such as some used for classifiers, hammers, or engines, is made in a short time with about half the expense of a new one and no loss of money from a shutdown. We have succeeded in making 75 per cent of the parts for our jackhammers. You know jackhammer parts do go West. Of course we do not add our time in these costs, for we are paid by the year anyway. Anyone that is handy, from manager to the lowly mill "supe," gets on the job when the occasion arises. We have no lathe man and don't want one. Sometimes we do not touch the lathe for weeks at a time. Don't say then that it is unnecessary expense, for it has paid for itself in one day, over and over again. Let's see:

Bar iron doesn't cost much when you compare it with what you save, and shafting isn't so expensive. We get a lot of our shafts from worn-out flotation and other shafts that would be no good and have to be thrown away were it not for yon lathe. All these things are put into our shafting stock near the lathe, and that's what makes the pieces.

A Night Call

One night the mill foreman woke me up about midnight and informed me that the mill had passed away—simply dead. He stated that he thought it would be so for at least two months. In questioning him, I found that a very delicate and difficult piece had broken on the main driving engine; the whole mill depended on it, and we had never thought that it even had a desire to break. I had him bring the broken piece up to the lathe room, and then I looked it over. If you have ever been on top of a 100-ft. diving tower looking way way down at the water that seems miles away, you will realize how I felt when I saw that piece. It was several feet long, was drilled the full length by a 1-in. drill, had four shoulders on it, and a foot and a half of threads of large size. The larger end was flattened and bored three times; the smaller end was tapered. Man, what a mean-looking job to even think of making!

By the time I had looked it over, and drawn a picture of how it should look if it were all in one piece instead of being broken, it was after 1 a.m. I got a 4-in. shaft out of our heap, a piece that had been used in the mill until it had seen better days, and placed it in the lathe. By dawn the holes were drilled, the shaft was hollowed, the threads were on and fitted, and the shoulders and the taper finished. Nothing left to do but to saw the part that I had not used. It was sent down to the mill with instructions to the mill foreman to saw it off where marked. Then I hit the hay—I'm not joking: it is hay—and got up again around 8 a.m. and, let me tell you, that mill was going. It has been running on that piece ever since, although we have a factory-made spare for it now if it ever gets a desire to leave us.

Another little enlightenment: This piece was made by myself with no one around to offer suggestions. I'm not trying to be a hero, but trying to let you know it's not difficult.

I'm not a lathe fiend. I'm just trying to wake some of the thinking men up. Think it over and get one. My parting advice is that which was given to me: start in slow; don't try to take too deep cuts until you know your tool, and your steel or iron. Then, pretty soon, you'll be good—like me!

Mining in French Equatorial Africa

LITTLE is known of the mineral resources of French Equatorial Africa, according to U.S. Vice-Consul John W. Bailey, Jr., of Loanda, Angola, although deposits of copper, iron, zinc, lead, and salt have been identified in certain localities. Copper, the only mineral that is being worked at present, is being extracted by the Compagnie Minière du Congo Français, which is exploiting a deposit on the right bank of the Djoue, between Brazzaville and the sea. This company was founded in 1905 with a capital of about $1,000,000. Zinc, lead, and iron also exist here and, with copper, are reported to be found in paying quantities on the upper Kwilu.

The only completed railway in the colony is the narrow-gage Decauville line, about 100 miles long, connecting Brazzaville with the copper mines at Minduli. This road was built and is operated by the Compagnie Minière du Congo Français and is not open to the public for the transportation of freight or passengers.

A railway connecting Brazzaville with Pointe Noire, a distance of approximately 580 km. (360 miles), is being constructed. It is reported that this road has been opened for a distance of 80 km. from Pointe Noire and 126 km. from Brazzaville and that it will be completed by 1930. An important revenue for this line is assured from the day of its completion, as a part of the traffic of the congested Congo Railway (Kinshasa-Leopoldville to Matadi) will doubtless be diverted to this route. It should prove to be a highly important factor in the development of the colony, as it will not only tap directly the productive regions of eastern Gabun and the Middle Congo, but, by assuring transportation from Brazzaville to the sea, should encourage development in the sections served by the river transportation on the Congo, Ubangi, and their tributaries, converging at Brazzaville.

Need for Research in Northern Ontario

"WITH so much money already spent on exploration and prospecting," says H. C. Boydell, in an article in the February *Bulletin* of the Canadian Institute of Mining and Metallurgy, "is it not time to take stock of the situation and ask seriously what really are the special geological conditions that have led to the formation of the few auriferous economic deposits so far found in northern Ontario? In such cases, evidently, there has been some exceptional combination of circumstances. What was it, this riddle of Pre-Cambrian mineralization? Every scrap of information on this subject is necessary. Surely the much needed research that would help is justifiable.

"Would it not ultimately pay the mining companies by co-operative effort to provide for such research?" he asks. "Surely, with due consideration of facts, the answer to such a question cannot but be in the affirmative. Once agreed on the necessity and utility of research, the form it should take would be a matter of merely careful consideration, its carrying out but a question of persistent, intelligent, well-directed effort, spurred on by knowledge of its important consequences, of the goal to be attained."

Control of Flotation

By A. M. GAUDIN
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CONTROL OF FLOTATION results from the application of the fundamentals on which the process rests. So long as these fundamentals remained secret, control of the process was not possible to any material degree. As the intricacies of flotation are gradually unraveled and the various factors entering into the problem disentangled, a more direct control of the process is made possible. At the same time, more and more difficult problems are attacked and solved, so that the delicacy of the control required is increased.

The difficulties encountered may broadly be divided into those arising in the testing and pilot plant stage, and those incidental to actual operation. Somewhat different methods are to be used in these two instances in overcoming the difficulties. In the first class, elaborate time-consuming testing is permissible if the magnitude of the improvement justifies the delay and expense; in the second, it is desirable that the operator be gifted with the highly esteemed scent for quick and efficient remedies.

CONTROL OF FLOTATION TESTING

When a new problem is attacked, the metallurgist avails himself of a representative sample of the ore and has it analyzed chemically. A mineralogical analysis would be more informative and is obtained by progressive investigators. Microscopic study of the mineral association is of great value in deciding upon the requisite fineness of grinding. With these data in hand, testing can begin. It may be that the ore responds easily to treatment and that success by the empirical cut-and-try method with well-known reagents is met at an early stage; on the other hand, it may be difficult to get results that can be duplicated or to get any satisfactory result at all. In such circumstances, more information concerning the degree of superficial alteration of the mineral grains is desirable. Sometimes this can be obtained by examination under the microscope; in other instances it can be inferred from leaching tests with discriminating solvents. Above all, a qualitative and quantitative determination of the soluble salts present in the ore should be made.

Inasmuch as most salts of polyvalent metals act either as activating agents for such sulphides as sphalerite and pyrrhotite or as non-selective toxic agents for various sulphides, they generally are responsible for failure to get the best separation. Knowledge of the kind and quantity of soluble salts present makes it possible to use the right amount of antiactivating, antitoxic, or conditioning reagents. Addition of these correcting reagents in the proper amount, resulting in the precipitation or removal as complex ions of the undesired metallic ions, eliminates one of the most prolific sources of trouble in differential flotation. Furthermore, the compounds resulting from the reaction of the correcting reagent added, and some metallic salt in solution, may tend to build up selectively at the surface of some of the sulphide minerals, resulting in selective depression. This instance, typified by lead-zinc ores containing soluble zinc salts and treated with sodium carbonate, illustrates the possibility of putting to use the otherwise undesirable soluble salts occurring in sulphide ores.

OPERATING VARIABLES

Following satisfactory results in preliminary testing and during pilot runs, a plant is built with the belief that the flow sheet and the reagents are adjusted as perfectly as possible. Every mill operator knows, however, that the amounts of reagents have to be adjusted daily to insure the most efficient operation. These changes are fundamentally all the result of changes in daily tonnage and grade of the ore, of changes in composition of the mill water, and in temperature. Mechanical imperfections also affect the results, but they are avoidable to a large extent if the best equipment is selected.

Variations in the ore are both quantitative and qualitative. Unless the operation is on a very large scale, the amount of ore fed will vary to some extent from day to day and to a greater extent from one month to another, depending upon general economic conditions and also upon the nature of the source of ore. Custom concentrators suffer in that respect much more than concentrators handling ore from one large mine whose exploitation is laid out months and years ahead of time; necessary curtailment in times of economic depression sometimes is of such a nature as to compel not a complete shutdown of part of the mill but a partial shutdown of all the mill.

QUALITATIVE VARIATION OF ORES IMPORTANT

The qualitative variation of ores has a greater effect on the operation of the flotation plant and is more frequent. It results from the inherent irregularities in the ore in respect to mineralogical composition and fineness of aggregation of the component grains. As a result, the chemical composition of the ore will show variations from day to day, but these variations will not be as marked as the structural and mineralogical variations combined. The variations in degree of alteration or tarnish of the mineral surfaces and variations in the soluble content of the ore must be considered as part of the variations in the mineralogical composition of an ore.

Changes in mineralogical composition and structure affect crushing; therefore, if crushing is carried on in open circuit, the size of the fine-grinder discharge varies in agreement with the tonnage and character of the feed. Inasmuch as ball mills and finishing rod mills are generally used in closed circuit with classifiers, and as the classifiers can be adjusted reasonably well to overflow a product of a certain fineness, the size of the classifier overflow will show variations that are dampened as compared with the variations in the fine-grinder discharge.

On the other hand, the circulating-load tonnage will show magnified variations, with the result that the time of contact of reagents and ore in the ball mill-classifier circuit shows very considerable variations. In conclusion, one may consider that the only serious effect, from a flotation point of view, of changes in the quantity and quality of the ore, up to the beginning of the flotation section, is the comparatively large variations in time of contact of ore and reagents in the ball mill-classifier circuits induced by smaller variations in the feed. Fluctuations in the pulp density and fineness of grinding also occur, but they are of small magnitude if suitable control is used in connection with the classifiers.

Variation in the mineralogical composition of the ore results in changes in the proportion of the various products of the flotation section of the concentrator, particularly the proportions of the various concentrates and the bulk of the middlings that are circulated. Although variations in feed assays result in substantially proportional variations in the tonnages of the various products, the size of the middling products that require treatment or are circulated may be increased or decreased disproportionately, causing equally large changes in the rate at which the pulp is circulated through certain portions of the mill. This, in turn, is likely to affect, favorably or unfavorably, the perfection of the separations accomplished.

Variations in the soluble salts or toxic content of the ore have a profound effect on the performance of the concentrator and are overcome by an adequate change in the amount of the antitoxic reagents. Variations in the tarnishing of mineral surfaces, if any, are controlled by changes in the amount of collecting and depressing agents.

Alterations in the mechanical features of a mill, likely to vitiate results, involve irregularities in the power used —in the aëration of the cells because of lack of regularity in the air main in those installations using pneumatic cells, or because of variations in speed of the motors operating mechanically agitated machines.

Mill Water

Variations in mill water are due to somewhat different causes, according as the mill is using fresh water or returned-circuit water. Where fresh water is used, the change in mineral and organic content is one of the big upsetting factors—particularly true in places where climatic conditions affect the amount of water available, where periods of oxidation of the ground alternate with periods of heavy precipitation. When mine water is used, variations are also likely to occur as new sections of the mine are opened up.

If the water is returned to the mill after use—where circuit water is the dominant ingredient—the water is usually more regular in its mineral content than if fresh water only is used. On the other hand, excess reagents can build up rapidly under such conditions, so that accurate control of the amount of reagent is still more essential. For example, assume that a certain mill requires a pine oil content of 0.10 lb. per ton of ore during flotation, that 0.5 ton of fresh water is added for each ton of ore, that 0.02 lb. of pine oil is adsorbed per ton of ore, and that the pulp dilution during flotation is 5:1. After the float, the pine oil content of the return water is $\frac{(5-0.5)}{5} \times (0.10 - 0.02) = 0.072$ lb. per ton, meaning that 0.028 lb. of pine oil must be added for every ton of ore treated. If 0.002 lb. of pine oil is added consistently in excess during 24 hours, on a 20-min. circulating-time basis, the excess at the end of that time would be $72\left[\frac{(5-0.5)}{5}\right] \times (0.002) = 0.128$ lb. per ton, a large excess indeed.

Variations in pulp temperature in general do not have a seriously detrimental effect on flotation control, because they are gradual enough to allow ready adjustment. In some plants the pulp is heated with waste-heat steam in the winter time.

Minimizing Reagent Adjustments

All the variations indicated can be met by suitably adjusting the quantities of the various reagents, although the aim of several control factors is to minimize the necessity for adjusting reagents that require the attention of skilled and expensive operators. Because of the importance of accurate addition of reagents and the frequent necessity for adjusting the amounts added, a great deal of attention should be devoted to the means of adding the reagents. Reagent feeding devices should be conveniently located, preferably near each other; they should be easy to adjust, accurate and reliable. A small extra expense in the selection of a good feeder will generally pay for itself in better reagent control, increased reagent economy, improved metallurgical results, and less bother to the operator.

The final criteria of successful flotation are the securing of clean concentrates and high recoveries. In many instances the use of pilot tables on several of the various products of the plant pays for itself in affording an immediate picture of the work of the flotation cells, and a possibility for correcting evils before it is too late. Besides these advantages, pilot tables not infrequently make a worth-while metallurgical improvement in the grade of the various concentrates. This practice is highly commendable.

Control in conditioning following the float of one mineral and preceding that of another is generally conceded necessary, and most differential flotation lead-zinc plants are equipped with conditioning tanks to prepare the pulp after the lead float. The use of controllable conditioning tanks ahead of the lead circuit, to replace the irregularity of contact between reagents and ore in the fine grinders, would be a decided improvement in the construction of flotation plants, inasmuch as one source of variation would be eliminated.

The effect of the variations of the relative bulk of the various concentrates and tailings can be minimized by providing extra cell capacity with easily controlled valves for throwing in or out the required cells, thus maintaining the even rate of flow of the pulp.

Control of Reagent Content of Mill Pulps

The effect of variation in the soluble-salt content of the ore is one of the hardest to control, inasmuch as chemical determination of the soluble-salt content of water is a rather delicate and lengthy analysis and cannot be available until after the ore has been concentrated. As a rule, a slight excess of the antitoxic reagent should be used, so as to be sure that all of the toxic salts are removed. Control of the variations of the soluble salts can then be obtained by testing the pulp for the presence of that amount of antitoxic reagent that has been added in excess. This is done readily when the antitoxic reagent is distinctly not neutral, whether acid or alkaline,

by determining the pH of the solution. The pH of a solution is the opposite of the logarithm to the base 10 of the molal hydrogen-ion concentration of the solution. It follows that pure water has a pH of 7, inasmuch as the product of the H and OH ions of water is 10^{-14}. A normal strong-acid solution has a pH near 0, and a normal strong-base solution has a pH near 14. Good distilled water, which has stood in air, has a pH of about 6, owing to CO_2 absorption; and many ore pulps have a pH of from 4 to 5.5, owing largely to the acid oxidation products of pyrite. Addition of alkaline antitoxic reagent to eliminate the deleterious metallic salts brings the pH of the solution near that of water; and if these reagents are used in slight excess (for instance, of the order of 0.05 to 0.5 lb. per ton in excess of the amount required to remove completely the metallic salts), the pH may be as high as 9 or 10. Indicators to determine pH accurately are available in readily usable form, and have been found to be most dependable for controlling variations in soluble salts. The presence of the most desirable excess in solution of reagents that do not affect materially the pH of the solution can, of course, not be determined by this method; some other property of the reagent solution must be used, such as the formation of a precipitate or a colored solution by reaction with a suitable indicator. Examples are the formation of bright-yellow cuprous xanthate for the quantitative estimation of both copper and xanthate ions; the formation of complex copper-ammonium ion for copper; the formation of a red compound of iron and thiocyanates; and many others.

Frothing-agent estimation is best made by surface-tension measurements with the latest surface-tension balances, and rapidly, to the nearest tenth of a dyne. This corresponds to an accuracy of substantially better than one part in one million parts of water for most pine oils and other frothers. The reliability of the conclusion as to the amount present in solution lies in the fact that non-frothing substances in the solution do not materially affect its surface tension.

Conclusion

The control of flotation depends, therefore, on the adjustment of the reagents to their proper quantities by the operator, following his inspection of the various products of the mill, determination of the pH of the pulp solution, its surface tension, its soluble content, and other factors. It certainly is not mechanical control. To the largest extent it involves the ingenuity, far-sightedness, and experience of the metallurgist. In time to come, perhaps, mechanized, automatic devices will be available for regulating reagent control to perfection, by causing certain chemical or physical reactions carried on in a continuous manner on a sample stream of the flotation pulp, to affect by photo-electric or electrical means the rate of flow of the reagent into the circuit; but the day is not here yet, and perhaps this is not such an unpleasant thought for most metallurgists.

Tantalite Mining in Western Australia

TANTALITE is a rare mineral, but uses for the metal are being developed, chiefly in the United States, by the Fansteel Products Company, of North Chicago, Ill. As the demand increases it is probable that sufficient supplies will be forthcoming. Keystone, S. D., where so many rare minerals have been found, has been the chief source of supply in this country so far, though it has been reported in the last year that the Peerless Consolidated Copper Company is to develop a deposit at Hillside, Custer County, Colo. Prospectors would do well to be on the lookout for it in granite pegmatites, where it may be associated with beryl, tourmaline, spodumene, lepidolite, cryolite, quartz, feldspar, wolframite, and cassiterite. According to Kraus and Hunt's "Mineralogy," its fracture is conchoidal to uneven, often with iridescent tarnish. Its hardness is 6 and its specific gravity 5.4 to 6.4. It is brown to iron black in color, with a brownish, reddish, or black streak. The lustre is greasy, sub-metallic to dull.

The mining of tantalite is a growing industry in the Pilbara gold field of Western Australia, according to a report by Dr. Edward S. Sampson in the Dec. 5 issue of *Chemical Engineering and Mining Review*. This district is in the northwestern part of the province, the chief center being Marble Bar, from which a railway, 114 miles long, runs to Port Hedland, on the Indian Ocean. The Tabba Tabba tin and tantalum field is 8 miles from the 35-mile post on the Marble Bar railway, and is less than two miles square. Two leases are being worked here for tantalite. On one, at least two parallel pegmatite veins have shed abundant gravelly tantalite on the gentle slopes. Only this detrital ore at present is being recovered by dry concentration by hand (sieving). On the other lease is a prominent pegmatite vein, up to 40 ft. wide. Soft detritus alongside is being partly concentrated for tantalite by sieving, and the product, running about 10 per cent tantalite, is being carted to Wodgina (58 miles) for final dressing.

At Wodgina, the main pegmatite vein on the old tantalite mine is being opened up. A small plant, consisting of crusher, jigs, and table, receives high-grade tantalite from the soil on the slope below the outcrop, and to some extent from the lode. Concentrate is being produced at the rate of between 20 and 30 tons per annum, and is readily salable at about £200 per ton. The product consists of almost clean manganotantalite with a little spessartite (manganese garnet) and occasional pebbles of scheelite. The main vein is principally of coarsely crystallized albite, with irregularly distributed bunches of quartz, microcline and lepidolite, and small crystals of spessartite garnet. At the north end is a large mass of pegmatite, which has yielded much tantalite and other materials. Near the middle of the vein the coarse albite is thickly studded with tantalite in lumps from 1 lb. to 5 lb. in weight. Detrital tantalite can be picked up in the surface soil, and this in spite of the fact that over 70 tons of tantalite was obtained thus many years ago.

The mineral from this vein is remarkably uniform in grade and averages: Tantalic oxide, 68 per cent; niobic oxide, 14 per cent; manganese oxide, 13 per cent; iron oxide, 2 per cent. Buyers are disinclined to take concentrate under 63 per cent tantalic oxide.

Four radium minerals have also been found in association with the tantalite; also lithiophilite, carrying 8 to 9 per cent of lithia, and beryl, of use in the manufacture of electrical porcelain and light alloys.

DISCUSSION

Scope and Effect of Carson and Flotation Patent Litigation

Counsel for Anaconda Presents an Interpretation of Judge Bourquin's Decisions in Perkins and Carson Patent Issues—Text of the Federal Court's Decree Remanding Suit to Lower Court

THE EDITOR:

Sir—I wish to take the liberty of suggesting to you an error in your report of the action taken by the Circuit Court of Appeals for the Ninth Circuit in the case of Carson Investment Company against Anaconda Copper Mining Company on Feb. 27, 1928, both in the summary, on page 384, and the brief reference on page 385, of your issue of March 3, 1928.

From the summary it seems to me that your readers will obtain a distinct impression that the Court of Appeals has reversed the decision and judgment of Judge Bourquin, and it seems very clear that your report of the case on page 385 would have that effect.

The headline of the report is "Carson Wins Appeal Against Anaconda" and the article itself would, to the average reader, it seems to me, support this heading.

In the trial court, in the Anaconda case, the plaintiff, in its pleadings, set up that the Anaconda company, by reason of contributions to, participation in, partial control of, etc., in the Carson versus A. S. & R. case, became a privy to and bound by the decree in that case. The Anaconda company denied participation in the A. S. & R. case, except through certain financial contributions. Upon the trial, when Carson's attorney attempted to introduce proof on this issue, the defendant's counsel objected on the ground that the decree which had been entered in the A. S. & R. case was not final, but interlocutory, in character, and was not such as to finally adjudge the issues so as to estop the parties or privies in other litigation. Authority for this position was presented, and Judge Bourquin sustained the objection and declined to hear the proof. The Court of Appeals held that while a further and final decree will be necessary in the Carson case after the accounting, the decree entered was final and conclusive upon parties and privies as to issues of the validity of the patent and infringement, and directed that the proof upon the issue as to whether the Anaconda company had become privy to the other previous judgment, be taken. It held that money contributions to the defense of the A. S. & R. Company, in the former case, would not be sufficient to bind the Anaconda company, and laid down certain other essentials which would have to be proven, but merely directed that the proof be taken, findings made upon it by the lower court and reported to the Circuit Court of Appeals, that court expressing no opinion upon the merits of the issue. I enclose you copy of the opinion of the Circuit Court of Appeals rendered upon this matter, from which, I am sure, you will agree that the above correctly describes the action taken.

It may interest you to know that after this order, made by the Court of Appeals on last Monday, on Friday last counsel for Carson advised the Court of Appeals of their desire to waive any contention that the Anaconda company is bound by the previous judgment against the A. S. & R. Company, and asked the Court of Appeals to disregard Carson's contention in this respect and to decide the case upon the merits. This will obviate, undoubtedly, any necessity of the case going back for further proof.

I notice in this same issue, in your discussion of the decision of Judge Bourquin of the Montana Federal Court, in the Metals Recovery Company case, and the decision of the Maine court in the Magma case, that the decision of Judge Bourquin as to the Perkins patent has not been correctly interpreted. The latter part of this article states:

"In both cases the defense made a 'rallying-point' of the argument that the patents were too far-reaching in claims and scope. This condition, it was contended, was sufficient to nullify the patents, and therefore no infringement could exist. This argument was refused in the Magma case, but upheld, after a fashion, in the Metals Recovery vs. Anaconda suit."

I enclose you a copy in full of Judge Bourquin's decision, from which you will note that he based his decision on three grounds: first, that the claims of the patent relied upon were invalid as being too broad and general; second, that even if the claims were valid, there was no infringement, as xanthate did not come within the definition given in these claims; and third, that Perkins was not first in his discovery, but that xanthate had been found by R. B. Martin, and used at Utah Copper prior to the Perkins discovery.

Nothing could be clearer than Judge Bourquin's holdings as to the invalidity of the patent claims as being too broad and indefinite. He says in part:

"In view of the premises, defendant contends that the claims are invalid within the rule of the Incandescent Lamp Case, 159 U. S. 465; Bene v. Jeantet, 129 U. S. 683, and like cases. So doth it seem to the court. . . . This patent falls short of the statutory requirement."

And again:

"Moreover, the claims are too broad in that they include substances without all the essential attributes of the discovery. . . .

"This is not mere exclusion or limitation of the claims, but in legal contemplation is that no inclusion and expansion which invalidates them."

As I know that your desire is for accuracy in these matters, I concluded to advise you exactly of the action of the District Court and the Court of Appeals in the above cases.

Yours very truly,

L. O. EVANS,
General Counsel,
Anaconda Copper Mining Company.

[The brief report in our issue of March 3 of the decision of the Court of Appeals in the Carson case was based on a message telegraphed by our correspondent in San Francisco. We are glad to give space to Mr. Evans' views and interpretation; and likewise to publish the full text of the decision, so that readers can arrive at their own conclusion as to the effect of the findings of the Court. With respect to Mr. Evans' criticism of the comment on the Metals Recovery case, we are inclined to agree that the point is well taken in so far as the deletion of the words "after a fashion" would make the statement more positive.—EDITOR.]

The decision of the U. S. District Court in the Carson appeal follows:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

CARSON INVESTMENT COMPANY, a Corporation, et al.,
Appellants,
vs. No. 5228

ANACONDA COPPER MINING COMPANY, a Corporation,
Appellee.

Before HUNT, RUDKIN and DIETRICH, Circuit Judges.

HUNT, Circuit Judge:

The Carson Investment Company and Miller, as trustee, appeal from a decree dismissing their complaint against the defendant-appellee, Anaconda Copper Mining Company, for infringement of patents No. 1,149,495, (Aug. 10, 1915) and No. 1,302,307, (April 29, 1919), both relating to reverberatory furnaces for smelting copper and other ores issued to George C. Carson. (Carson Investment Co. v. Anaconda Copper Co., 17 F. (2d) 815).

History of the patents will be found in the opinion in Carson vs. American Smelting & Refining Co., 4 F. (2d) 463, wherein, on appeal from the decree of the United States District Court for Washington, we held that the two patents were valid, that they had been infringed, that injunction should issue, and that accounting should be had. The decree of this court reversed the decree of the District Court, and remanded with directions to enter a decree in accord with the views expressed in our opinion.

In due course the case went back to the District Court for Washington, and in accordance with the mandate of this court a decree was entered, sustaining the patents adjudged infringed, awarding perpetual injunction, ordering an accounting of damages and profits, and referring the case to a master to take the accounting.

In the present or Montana case, the Carson Company, by a supplemental complaint, alleged the pendency of the above mentioned case against the American Smelting & Refining Company and the decision and decree of the Circuit Court of Appeals therein; averred that the machines and processes used by the Anaconda Mining Company and alleged in the original bill of complaint to be infringements upon the patents in suit, are substantially identical with the machines and processes used by the American Smelting & Refining Company, which were adjudged by the Court of Appeals to be infringements upon the patents in suit. It was further alleged that the patents involved and the issues raised in the suit of Carson vs. American Smelting & Refining Company, supra, are the same as the patents involved and the issues raised in the present suit against the Anaconda Company; that immediately upon the commencement of the suit of Carson vs. American Smelting & Refining Company in the District Court for Washington, the Anaconda Company, appellee herein, joined and co-operated with the American Smelting & Refining Company in the defense of that suit by employing and paying counsel to conduct, and who did conduct the defense thereof by hunting up evidence and witnesses who testified in the case, by carrying on all the activities and exercising all the rights of a defendant, and by conducting the defense in conjunction and in co-operation with the American Company, to the same extent as they would have been entitled to do if the Anaconda Copper Mining Company had been named as a formal defendant therein and had been charged in the complaint with infringement of the patents in suit; that the Anaconda Copper Mining Company continued to act cojointly and co-operate with the American Smelting & Refining Company in the defense of said suit during all its stages and proceedings in the District Court of the United States for Washington, and in the matter of the appeal heretofore referred to in the United States Circuit Court of Appeals for the Ninth Circuit; that all of the aforesaid acts and doings of the Anaconda Copper Mining Company in respect to the defense of the suit of Carson against the American Smelting & Refining Company, both in the District Court for Washington and in the United States Circuit Court of Appeals for the Ninth Circuit were had, taken and done by the Anaconda Company openly and publicly, and to the knowledge at all times of the said Carson, whereby the Anaconda Copper Mining Company became a privy to and with the American Smelting & Refining Company, defendant in that suit, and bound by all the proceedings, orders, opinions and decrees rendered therein, as fully and completely as if the Anaconda Company had been named as a defendant.

Defendant answering, admitted that the patents were the same, and that the Anaconda Company had contributed money to the defense in the case in the District Court, but denied the other allegations.

When the present case was brought to trial, plaintiffs called as a witness, Mr. Usina, who had participated in the examination of witnesses in the American Smelting & Refining case, and was an attorney of record for the defendant in the instant case, After a few preliminary questions, the Court asked what was the object of the examination. Counsel for plaintiffs stated that it was to elicit facts showing privity by virtue of the agreement between the American Smelting & Refining Company and the Anaconda Copper Company as to a joint defense of the American Smelting & Refining Company case. Upon objection by defendant the Court ruled that the decree in the American Smelting & Refining Company case was merely interlocutory, was subject to change on appeal from the accounting, and, therefore, was not res ajudicata as against the American Smelting & Refining Company, or anyone else. The witness was then directed to leave the stand, and counsel for the plaintiffs were not permitted to question him further. The Court also rejected plaintiffs' offer of a certified copy of the decree in the American Smelting & Refining Company case, which decree the District Court in Washington had entered pursuant to the mandate of the Circuit Court of Appeals. The trial was then proceeded with, and after much evidence was heard, the patents were held to be invalid upon the grounds that they had been anticipated, that there had been prior use, and that certain alleged false and fraudulent misrepresentations had been made by Carson to the officials of the Patent Office during the pendency of his application for patent.

A clearer understanding is had by mention of these additional facts: The suit of Carson vs. American Smelting & Refining Company, supra, was instituted in the District Court in Washington in November, 1921. The Circuit Court of Appeals in February, 1925, made the order and decree above outlined. (Carson vs. A. S. & R. Co., 4 F. (2d) 463). Petition for rehearing was denied, and writ of certiorari was denied by the Supreme Court. (Carson vs. A. S. & R. Co., 269 U. S. 555). The American Smelting & Refining Company then moved the Circuit Court of Appeals for permission to be granted to the District Court to consider a motion to reopen the case for the purpose of allowing the introduction of certain newly discovered evidence, especially pertaining to alleged prior use at Dollar Bay, Michigan. Many affidavits filed in support of the application to reopen set forth that the newly discovered evidence was not known until after the decision of the Court on the merits in February, 1925. This court held that the evidence outlined in the affidavits was not sufficient to operate as an anticipation, and on March 1, 1926, denied the application to reopen. (Carson vs. A. S. & R. Co., 11 F. (2d) 766). The American Smelting & Refining Company also applied to this court to abate the suit on the grounds that Carson was not a proper party to maintain it, inasmuch as he had assigned the legal title to the patents to his attorney, John H. Miller, as a trustee. That motion was denied. (Carson vs. A. S. & R. Co., 11 F. (2d) 764).

To review our decision in that matter, the American Smelting & Refining Company applied to the Supreme Court for a writ of certiorari, but the application was denied on October 11, 1926. (Carson vs. A. S. & R. Co., 273 U. S. 695). Thereafter, when the mandate from the Circuit Court of Appeals went down to the District Court in Washington, there was a hearing as to the alleged defect in parties, and John H. Miller as trustee, and the Carson Investment Company, a Corporation, were joined as co-plaintiffs with Carson.

The interlocutory decree hereinabove referred to was then entered, and the accounting is still pending.

Under the facts stated, at once the question arises, whether the decision and decree of this court in American Smelting & Refining Company case as to the validity and construction of the patents is res adjudicata, not alone as to the defendants of record to that suit, but is an estoppel as to those in privity with the defendant therein.

It is very clear that the decree of this court in the American Smelting & Refining case in its essence and substance was final as to the validity of the patents involved, and as to the fact that there had been infringement. The questions of novelty and infringement were the pivotal ones before the court. They were considered and conclusively disposed of by our decree; hence they were finally settled.

It was not in the power of the District Court to open them, unless, after permission granted by the Circuit Court of Appeals. The Supreme Court in In Re Potts, 166 U. S. 263, referring to the duty of the lower court in a case where a patent was held valid and infringed and that the infringer must account, said that the lower court could not vary or examine the decree of the Supreme Court for any other purpose than execution; or give any other or further relief, or review it even for apparent error, upon any matter decided on appeal; or intermeddle with it further than to settle so much as has been remanded. The Supreme Court also referred to a distinction between a final decree that wholly disposes of all the issues, and a decree which may not be technically final, because there remains the matter of an accounting, and expressed the opinion that while the matter of accounting for infringement still remains for disposition in the lower court, the decree and decision upon the questions of novelty of the alleged invention and of infringement had been presented, considered and decided by the

Supreme Court, and must, therefore, be deemed to have been finally settled and could not afterward be reconsidered by the lower court. We regard that case as sustaining the principle that if in a patent litigation a decree finally determines the principal issues of validity and infringement presented by the pleadings, and settles the litigation over those issues, it is so far conclusive as to determine other litigation between the same parties over the very same issues. The term "interlocutory decree" does not lessen the real character of such a judgment when, in other litigation over the same issues between the same parties, the plea of res adjudicata is set up.

In Hart Steel Co. vs. R. Supply Co., 244 U. S. 294 (1917), on certiorari, the Supply Company sued the Hart Company and Wood in the United States District Court in Illinois, praying injunction for infringement. Three months later the Supply Company sued the Elyria I. & S. Company in the United States District Court in Ohio for the same relief as against it, as had been sought in the suit in Illinois. The Elyria Company owned all the capital stock of the Hart Company, which was the selling agent of the Elyria Company, with Wood as manager. The Illinois case was dismissed on the ground that there was no infringement, and at a later date, in the Ohio case, similar decree was made. Appeals in both cases were taken, and in the Ohio and second case the Court of Appeals for the Sixth Circuit affirmed the decree of the District Court. Soon thereafter, however, in the Court of Appeals for the Seventh Circuit, where the appeal was still pending, the Hart Company and Wood moved the Court of Appeals to affirm the decree of the District Court on the ground that the issues had been adjudicated by the Court of Appeals of the Sixth Circuit, wherein the Elyria Company was in privity with the Hart Company and Wood. The Court denied the motion. Afterward, when the appeal was argued on its merits, the Court of Appeals held the patents valid and reversed with directions to take an accounting. On review by the Supreme Court, the question considered was whether or not the decree in the Sixth Circuit Court of Appeals was a "final determination" of the issues presented in the case pending in the Seventh Circuit Court of Appeals, so as to be res adjudicata and binding on that court. It was held that there was identity of interest, that the Hart Company and Wood, as agents, were necessarily privies to the judgment rendered in the Sixth Circuit in favor of the Elyria Company, and that the Court of Appeals for the Seventh Circuit erred in overruling the motion to affirm the decision of the Court of Appeals for the Sixth Circuit. "The doctrine of res adjudicata," said the court, "is not a mere matter of practice or procedure inherited from a more technical time than ours. It is a rule of fundamental and substantial justice * * * which should be cordially regarded and enforced by the courts, to the end that rights once established by the final judgment of a court of competent jurisdiction shall be recognized by those who are bound by it in every way wherever the judgment is entitled to respect." See also, Larkin vs. Barrett, (CCA 7, 19 F. (2d) 944); National Brake & E. Co. vs. Christensen, (CCA 7, 258 Fed. 880). The last mentioned case, an application for an order dismissing a bill, has a bearing, and although the decision was reversed by the Supreme Court (254 U. S. 425), the principle apposite to our case was not disturbed. Judge Baker said: "Indeed, throughout the world of English derived jurisprudence, there is unanimity that a decree which on issued joined, and on submission by the parties and consideration by the Court of all the evidence, the parties can or choose to adduce and all the law the parties and the court deem applicable, adjudges that the complainant is the owner and entitled to the exclusive possession of property and that the defendant has unlawfully invaded the complainant's rights, and orders the defendant to surrender or keep away from the property forever, is a final decree on those issues, even though the issues concerning profits or damages from the defendant's trespasses had been reserved for future judicial action." (See also National Brake & Elec. Co. vs. Christiansen, 278 Fed. 491).

Appellee cities Simmons vs. Grier Bros. Co., 258 U. S. 82, as holding that where inquiry before the master is necessary before a final decree can be had, there can be no final decree in the suit. In stating that rule, the court had before it the question whether on an application to file a bill of review a decree, such as was entered in the American Smelting & Refining Company case, was final. It was held not to be final, and that a bill of review could not be brought. The court applied the strict rule that a bill of review is only called for after all controversies between the parties are settled by final decree which adjudicates upon the entire merits, leaving nothing to be done except the execution of the decree. The court did not disapprove of the Potts case, supra, and we find no necessary inconsistency between the two decisions. Merrian Co. vs. Sallfield, 241 U. S. 22, may also be harmonized with the Potts case. The decision there was upon a question of jurisdiction of the District Court to enforce a decree against one who was a non-resident stranger to the main suit, and who was served by substituted process after supplemental bill was filed. Brown Shoe Co. vs. Wolfe, 240 U. S. 251, also cited, a trade-mark case, decided that a decree of the District Court ordering an injunction and accounting with respect to the trade-mark was not so far final as to give the right to apply to the Supreme Court for a writ of certiorari. The case is not authority for holding that in a patent suit a decree sustaining the patent as valid and ordering an accounting is not final, in so far as it affects the validity of the patent.

Considered merely with relation to right of appeal to this court, the decree entered in the District Court in pursuance of the mandate of this court is clearly res adjudicata against the American Smelting & Refining Company in so far as it determined validity and infringement of the patent, for on those points no appeal would lie. If, after accounting has been had, appeal may be taken only the proceedings subsequent to the mandate would be presented for review. (Roberts vs. Cooper, 20 How. 481; Illinois vs. I. C. R. Co., 184 U. S. 91).

The sequel of our views is that the decree in the American Smelting & Refining Company case being res adjudicata as to the issues referred to between parties of record in that suit, it is equally conclusive as to the same issues upon those in privity with the American Smelting & Refining Company. We agree with appellee in the contention that the judgment could not be relied upon as an estoppel merely because the Anaconda Copper Company contributed some money toward the defense of the American Smelting & Refining Company suit, gathering testimony for the defense, but that does not meet the broader proposition that if the Anaconda Company directed its counsel to confer with counsel for the American Smelting & Refining Company, and if such counsel participated in the preparation of the case for trial and in the trial of the issues, and if the Anaconda Company had the right to exercise joint control over the litigation, and did actually co-operate with the American Smelting & Refining Company in the trial and appellate courts, all as more particularly alleged, it became privy to the American Smelting & Refining Company suit and bound by the decree therein as to the validity of the patents and the infringement of them; wherefore, the decree in the American Smelting & Refining Company case should be an estoppel upon the issues of validity and infringement. (Miller vs. Liggett & Myers, 7 Fed. 93; Norton vs. San Jose, 79 Fed. 793; Theller vs. Hershey, 89 Fed. 575; General Film Co. vs. Sampliner, 252 Fed. 443.)

It was error, therefore, on the part of District Court to refuse to allow the plaintiffs to introduce the testimony offered in support of the issue of privity. Had plaintiffs prevailed on that issue it would have been unnecessary to inquire into the validity of the patent or its infringement. And in orderly procedure, we think it ought first to be disposed of here. Directions will therefore issue to the District Court that upon notice to the parties and with reasonable dispatch, it take the evidence upon this issue and cause the same, together with its findings thereon, to be certified to this court; and when so certified such supplemental record will be deemed to be a part of the record upon the present appeal, having the same force and effect as if it had been a part of the original record, without further formality of appeal or assignment of error. Each party will in the first instance pay its own costs, but the same will, upon final disposition of the case, be justly taxed.

Should the parties desire to simplify the record and avoid expense, by stipulating the facts, or by agreeing upon some other economical mode of taking the evidence, or should any further directions be required, appropriate orders will, upon application, be entered.

ENDORSED: Opinion. Filed February 27, 1928.

F. D. MONCKTON, Clerk. By Paul P. O'Brien, Deputy Clerk.

A True Copy.

Attest: February 27, 1928.
F. D. MONCKTON, Clerk.
By Paul P. O'Brien,
(Seal) Deputy Clerk.

Rocky Mountain Club's Last Round-up

The Rocky Mountain Club, long known as "The Eastern Home of Western Men," will give its farewell dinner at the Ritz-Carlton, in New York City, on Wednesday evening, April 11. Members in the West anxious to participate but who may be unable to attend in person are sending in reservations and are inviting friends from the West now in New York to be their guests. The dinner will conclude 21 years of the club's existence and will mark the consolidation with the American Institute of Mining and Metallurgical Engineers, members of which are invited to participate. Herbert Wall, secretary of the club, 42 Broadway, is chairman of the dinner committee.

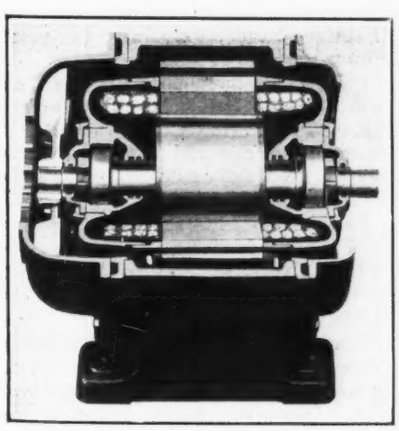
INDUSTRIAL PROGRESS

The Equipment Review

Haulage—Thirty locomotives have been ordered from the George D. Whitcomb Company, Rochelle, Ill., for the Russian Imperial Railways Commission. They are to be used in building 1,000 miles of new railway from a junction with the present trans-Siberian railway south through Turkestan to a point near Afghanistan. The locomotives are all of the internal-combustion type, powered with heavy-duty Climax engines. They will burn kerosene and will develop 122 hp. at a speed of 1,000 r.p.m. The order includes twenty 12-ton and ten 18-ton locomotives.

Shipments of mining and industrial electric locomotives for the quarter ended Dec. 31, 1927, as reported to the U. S. Department of Commerce by ten firms, comprising practically the entire industry, were 173, valued at $866,106, as against 195, valued at $898,970, for the quarter ended Sept. 30, 1927; and 330, valued at $1,684,792, for the quarter ended Dec. 31, 1926. Total shipments of mining and industrial electric locomotives for 1927 were 882, valued at $4,191,113, compared with 941, valued at $4,551,919, for 1926.

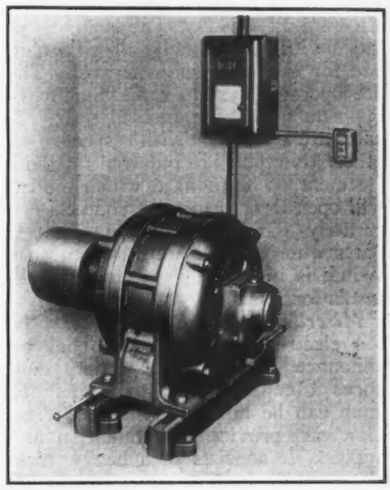
Power Shovels—A so-called "single-shaft-drive" caterpillar-type mounting for shovels and cranes has been developed by the Bucyrus-Erie Company. This drive is non-clogging, even when it is shoveled full of dirt, according to the manufacturers. The drive chains, of hardened forged steel, are self-cleaning. The mounting easily takes grades of 30 per cent and steeper. A two-way brake, which operates with a ratchet effect, allows free movement in either direction as desired, but locks the machine against the digging or on a grade. Sharp turns can readily be made. All parts are accessible and any wearing parts can be removed without disturbing the others. The one gear and its pinion are inclosed and operate high above the ground, with 12-in. clearance. The truck frame is practically indestructible, being a one-piece annealed steel casting 23 in. deep. All treads have 1½-in. hardened steel pins. All of the company's gas-air and B-2 steam machines are being furnished with this mounting as standard equipment.

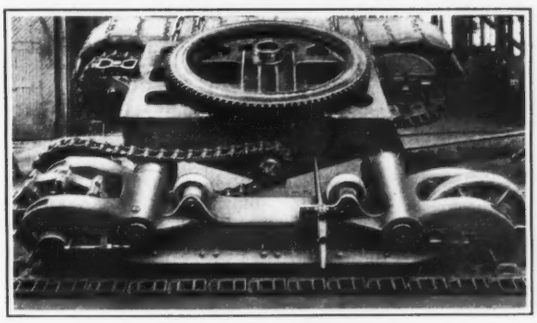


A new completely inclosed ventilated motor with a 40-deg. rating

Screens—The Newark Wire Cloth Company, of Newark, N. J., has announced a wire cloth having 160,000 square openings per square inch. This is a 400-mesh wire cloth with 400 parallel wires per inch of width running each way at right angles. In a 2½-in. square of this cloth there are one million square microscopic openings. Heretofore, according to the company, the finest wire cloth made in the United States has been 325 mesh. The company makes wire cloth of all malleable metals, from steel to gold and platinum.

Motors—A new, completely inclosed ventilated motor with a 40-degree rating has been perfected by the American Electric Motor Company, of Cedarburg, Wis. (now a subsidiary of the Splitdorf-Bethlehem Electrical Company). Dust is effectively excluded from the winding, which is hermetically sealed by the inclosed hoods. Cooling of this (Type P-K) motor is effected by driving air through the stator laminations as well as over them. The stator core is perforated, thereby making it possible to remove the heat at the point where it originates. Air in the inclosed portion is agitated by malleable cast fans shrunk on the motor shaft. Ball bearings are of the cage type. The stator is removable. The rotor is of the usual construction.





Above. A squirrel-cage induction motor for starting on full line voltage. At left, a "single-shaft drive" caterpillar-type mounting for shovels and cranes

Allis-Chalmers has introduced a line of squirrel-cage induction motors suitable for starting on full line voltage. These motors are normal-torque, high-reactance machines and will not draw starting current in excess of the limits recommended by the Electrical Apparatus Committee of the National Electric Light Association. They are built in ratings 7½ to 30 hp., 600 to 3,600 r.p.m., low voltage, and are available with either sleeve or roller bearings. A magnetic switch with push-button control is the only starting equipment required.

A new automatic induction starter with two adjustable features has been announced by the Lincoln Electric Company, Cleveland. One of these adjustments is in the starting current and starting torque and is effected by changing the position of the rotor in the regu-

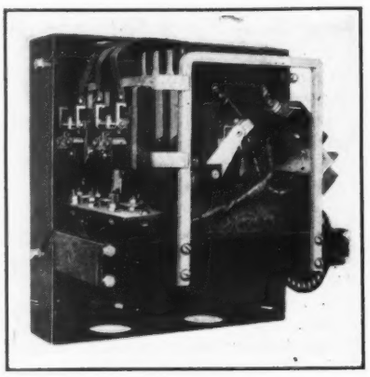
lator. This rotor is index mounted and the starting torque and starting current of the motor are increased by going to the higher numbers of the scale. The other adjustment is in the current at which the throw-over takes place. The throw-over is controlled by a retarding solenoid which is operated by the motor current; and the pull of the solenoid can be adjusted by a simple lock rod arrangement carried on its plunger.

General Electric has introduced a newly designed limit switch for controlling the limits of travel on such applications as motor-operated window or door-opening apparatus, valves, and other devices, where magnetic control is used. This is given the designation of CR-9441-LS-424-A. The switch is provided with two normally closed contacts, one for each extreme of travel. These are operated by two cams, mounted on opposite faces of a molded gear. The cams are adjustable with respect to each other. No tools are required for the adjustment. The point at which the cams will open their respective contacts is accurately fixed. Protection from live parts when making adjustments on the switch is insured by the use of molded insulation parts.

Miscellaneous Supplies—A new Edison electric safety trip lamp has been announced by the Mine Safety Appliances Company, of Pittsburgh. This lamp can be hung on the side or back of a car, providing illumination at all angles. It consists of a heavy, nickel-plated steel battery container holding two standard Model E Edison cells. The container is locked magnetically and is held to the car by means of a heavy forged steel holder. The ruby-glass cylinder surrounding the bulb is screwed and locked in place by means of a heavy, cast ribbed top. The lamp can be charged on Model E or G Edison racks by special placing of charging clips.

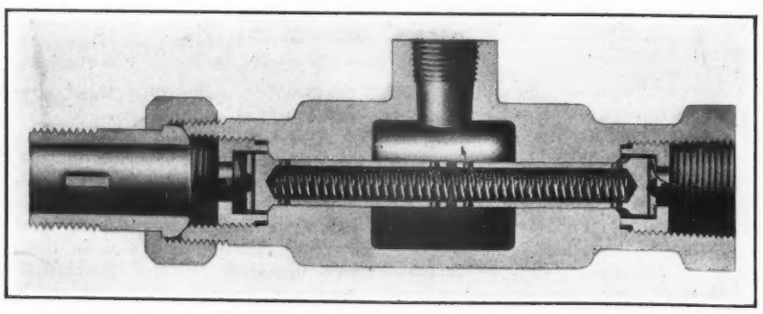
The Power Plant—The Waukesha Motor Company, Waukesha, Wis., has announced the latest addition to its line of industrial engines—namely, a new four-cylinder unit which follows many of the features of models previously turned out. The bore and stroke are 6½ x 7, giving it a piston displacement of 929 cu.in. This engine is a companion to Model JS 5½ x 7 and JL 6 x 7 and is known as Model JK. Its features are: Ricardo combustion chamber, truncated cylinders cast in pairs, twin-cast demountable cylinder heads, deep, cast-iron crankcases, with oversize center bearing, full pressure oiling, and a Waukesha built-in governor. The engine is available as a complete portable power unit for belt, gear, coupled, or chain drive, or independently for installation by manufacturers of power-driven equipment.

One of the accompanying illustrations shows a cross-sectional view of the Michael automatic drain valve made by the Sherwood Manufacturing Company, 1702 Elmwood Avenue, Buffalo, N. Y.



New automatic induction starter

This valve, according to the manufacturer, automatically removes entrained water and condensation from any steam cylinder during the operating periods and keeps the cylinder drained while idle. The substitution of this valve for the two commonly used drain valves on a steam cylinder eliminates all uncertainty as to what is in the cylinder and all danger of packing or cylinder-head blowout or damage. Economy of steam and greater output of useful mechanical work are obtained, the manufacturer claims, because the continuous removal of water as quick as it enters or forms prevents excessive cooling of the cylinder and protects the lubrication. The valve eliminates the necessity of paying attention to the cylinder drainage. On steam locomotives two of these valves automatically do the work of four hand-operated valves without the use of levers or of air operating lines, and without the escape of any steam to obstruct the engineer's view.



Section through new automatic drain valve. Both valves normally stand open. Steam entering one end of the cylinder closes the corrsponding valve

BULLETINS

LUBRICATION—Dot Lubrication Division, Carr Fastener Company, 31 Ames St., Cambridge, Mass. Bulletin entitled "Better Lubrication for All Machinery." Sixteen pages.

VALVES — Wellman-Seaver-Morgan Company, Cleveland, Ohio. Bulletin No. 89 on the Wellman Supertest gate and globe valves. Twenty pages.

ROD MILL—The Mine and Smelter Supply Company, Denver, Colo. Catalog No. 73 on the Marcy open-end rod mill.

MINE CARS—The Atlas Car & Manufacturing Company, Cleveland, Ohio. Bulletin 1231, covering industrial car equipment for mines, smelters, quarries, and contractors. Twelve pages.

STOKER—Detroit Stoker Company, Detroit, Mich. Bulletin covering the Detroit "UniStoker." Eight pages. Another bulletin, of 24 pages, describes the Detroit underfeed stoker.

FIRE PROTECTION—The first issue of *The Modern Chief* has been received from the American-La France & Foamite Corporation, Elmira, N. Y. This publication will carry on the work of its two predecessors, *The American-La France* and the *Industrial Fire Chief*, magazines that were devoted to spreading knowledge of fire-protection engineering.

BEARINGS—The Rollway Bearing Company, Syracuse, N. Y. Catalog No. 4-A, covering Rollway cylindrical roller bearings. Also four bulletins on kindred equipment.

CAR DUMPERS—Roberts & Schaefer Company, Wrigley Building, Chicago. Bulletin No. 103, covering rotary car dumpers. Eight pages.

WATER SUPPLY—The Air Conditioning & Engineering Company, 2914 South Jefferson Ave., St. Louis, Mo. A four-page bulletin covering the "Electrozone" water sterilizers.

ELECTRIC LOCOMOTIVES—Atlas Car & Manufacturing Company, Cleveland, Ohio. Bulletin 1229, covering the Type H storage-battery locomotive for metal-mining service. Four pages.

CONTROLLERS—General Electric Company, Schenectady, N. Y. Bulletin GEA-887, covering CR3110 drum controllers for series and compound-wound motors used on crane hoists and for similar applications.

CONCRETE—Celite Products Company, 1320 South Hope St., Los Angeles. Bulletin No. 336, entitled "Designing Concrete for Workability as Well as Strength." Eight pages.

WATTMETER—The Bristol Company, Waterbury, Conn. Catalog 1502, wattmeter section. Twenty-eight pages.

ARC WELDING—Fusion Welding Corporation, 103d St. and Torrence Ave., Chicago. A 4-page bulletin covering Fuzon arc welders.

FENCES—Sweet's Steel Company, Williamsport, Pa. Fence post of special high-carbon steel. A folder describing practical methods for testing the safety factors of steel posts.

NEWS OF THE WEEK

Summary

INQUIRY into the Hollinger disaster was held last week. The evidence presented was conflicting. This, combined with the size of the organization, makes the task of the provincial commission in fixing the responsibility difficult.

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Secretary Work denies a rehearing on mineral locations on oil-shale lands in Utah, Colorado, and Wyoming.

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Combination of the small tin producers and elimination of speculation are two solutions offered in London as the tin price fails to rise.

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Gold mining in Mojave County, Ariz., is in good condition. Several of last year's strikes have developed into sizable orebodies.

* * *

President of Pend Oreille Lead & Zinc denies that any other company is interested in his, thus contradicting the rumor that the recent sensational rise in price of the Pend Oreille stock is the result of acquisition of control by Consolidated M. & S. of Canada.

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United Engineering Societies continue their appeal for funds from engineers for the Louvain memorial, to be dedicated July 4.

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J. O. Elton and S. R. Moore, Western mining men, urge favorable legislation by Congress during a visit to Washington.

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Graphite property in Ontario suffers fire loss of $100,000. Mill and other surface buildings of Black Donald are destroyed.

* * *

Labor situation at the Rand is more encouraging. January figures show a decided increase in number of native labor employed.

* * *

Alaska railway, for the first time in its history, shows a profit, attributed in part to large shipments of dredging machinery to the gold fields.

Calumet & Hecla Is Dewatering Old Cliff Mine on Keweenaw Peninsula

AT THE old Cliff mine, in the Keweenaw County, Michigan, copper district, which will be used by Calumet & Hecla Consolidated for exploratory purposes, dewatering operations have reached a point below the 1,600 level in No. 4 shaft, into which the other shafts drain. Approximately 100 ft. remain to be pumped free of water. Within 30 days it should be possible to make a survey of the bottom of the shaft and map out a program of procedure. It is probable that drifting as well as crosscutting will be done, with the possibility of diamond drilling at the crosscut terminals. No. 4 shaft is in good condition, and temporary guides are being erected for the installation of an electric hoist. Although some cutting out has been done in the shaft during the course of repairs, no mining has been attempted.

The Cliff exploratory project is attractive in a number of respects. There are numerous formations to investigate, and this can be done at a depth which gives reasonable assurance of settled ground. Exploration and development can be carried on through an unbroken stretch of territory, options on a total of 9,355 acres of intervening land of foreign ownership running for four years. The option on the Keweenaw Central Railroad runs for a similar term. This period, it is believed, is long enough to give an idea of the desirability of the various blocks of ground. Work will be vigorously pushed. The operating company possesses the economic advantages of expert supervision, electric power, railroad transportation, and use of equipment already on hand.

At Quincy, the work of crosscutting to the Pewabic bed from the 87, the new bottom level of No. 6 shaft, will be speeded. To give an idea of the extent of the stoping area of Quincy at depth, the 86 level extending from a point north of No. 6 to the south of No. 2 is now 3,500 ft. in length. Some stoping has been done in this drift and a total of 2,500 ft. is ready for stoping. In future mining operations in Quincy, the retreating system of stoping back from the boundary lines, will be used instead of the advancing system to the boundary lines. As the rock is mined, the ground will be permitted to cave, saving the cost of extensive timbering. Another temporary shutdown at Quincy was necessitated recently by a recurrence of so-called "air blasts" or earth shocks.

Annual meetings of Lake Superior copper mining companies will be held in March and April. No changes in operating policies are expected, but there is speculation as to what action will be taken by several of the companies concerning the future. No word has been received as to Seneca's intentions regarding resumption of operations, and this matter may be discussed at the annual meeting. Mohawk also may decide what course it will pursue at the Michigan mine this year, if any. Quincy's new financing plans also may be considered. Reports for 1927 generally should be favorable, inasmuch as the companies benefited from economies in operations and a better price for copper during the later months of the current year.

Shipments of copper out of the Michigan district in February were comparatively light. The bulk of the metal now is moving to Detroit and other mid-West points.

An Appeal to Engineers

IN MEMORY of the engineers of the United States of America who gave their lives in the service of their country and its allies in the Great War of 1914-18, a clock, with 48 "gold" stars of aluminum bronze in place of numerals, and a carillon of 48 bells, is to be erected in the tower of the new library building at Louvain, Belgium, a gift of the American people. The clock and carillon will cost $80,000, to be met by subscription from the members of the engineering professions and industries of the United States. Less than half the amount has been received or promised. A plea is made for contributions, of any individual amount, which should be sent to the Committee on War Memorial, 29 West 39th St., New York. The names of all contributors to the fund will be recorded in a memorial volume to be deposited in the Louvain Library. You are asked to cooperate in this worthy commemorative effort, which will assist in the promotion of international good will.

Moore and Elton, Western Mining Men, Urge Action From Congress on Mining Matters

By Paul Wooton
Washington Correspondent

A FLYING VISIT from two energetic Western mining men, who were delegates from the Western sections of the American Institute of Mining and Metallurgical Engineers at the recent New York meeting, did much to crystallize the growing sentiment in official Washington that the federal government is not doing its full part in the co-operation due a basic industry. The plea to this effect was made to the President, to the Secretary of Commerce, and at conferences attended by Western Senators and Representatives, by J. O. Elton, manager of the smelter of International Smelting, at Tooele, Utah, and Stanley R. Moore, of Wallace, Idaho.

The first step which it is desired that the federal government take in a policy of more active co-operation with the mining industry is to provide for increased work at the mining experiment stations, a proposition already before Congress in the form of the Oddie bill in the Senate and the Englebright bill in the House. In addition, it was urged that an important part of such a program should be the creation of a large central mining experiment station at Salt Lake City, such as is contemplated in the bill which Senator Smoot has introduced in the Senate.

The Smoot bill is approaching the large central station plan in the exact form followed by the legislation which authorized the establishment of the Eastern-Central station at Pittsburgh. It authorizes the construction of a $1,000,000 building at Salt Lake, for the purpose indicated. The Oddie and Englebright bills provide for an additional $275,000 for the existing experiment stations. It is contemplated in those two bills, which already have been strongly urged at this session of Congress, to increase by $25,000 annually the amount of money to be made available to the experiment stations at Tuscaloosa, Ala.; New Brunswick, N. J.; Minneapolis, Minn.; Rolla, Mo.; Salt Lake City, Utah; Tucson, Ariz.; and Seattle, Wash. In addition those bills propose to Fosterize the existing field stations at Berkeley, Calif., and at Reno, Nev. Under such an arrangement those two stations would be put on an equal basis with the other mentioned and would receive $50,000 each per annum. As a result of the conference with Mr. Elton and Mr. Moore it has been decided to amend the Oddie and Englebright bills by adding $50,000 for the field station at Moscow, Idaho, which also would be Fosterized.

In view of the favorable attitude of the President and of Secretary Hoover toward the plan, Messrs. Elton and Moore urged the Senators and Representatives from the metal-mining states to use the full weight of their influence to secure the legislation at this session of Congress. It was pointed out by the legislators that with the active support of the ten mining states immediately involved it may be possible to get through the authorization bills in time to include the appropriation in the second deficiency bill. It was admitted that if the Senators and Representatives of the ten states involved were to get actively behind the proposition it could be put through at this session. It was pointed out, however, that much depends on the industry, as members of Congress from non-mining states will have to have convincing evidence that the public in the West is demanding the legislation.

Labor Situation on the Rand Improves

SHORTAGE of labor, which not long ago was a most pressing problem on the Rand, is being slowly overcome. As yet, however, there is no definite agreement with the authorities of Portuguese Africa on the importation of labor. Latest figures show that the number of workmen employed by the Witwatersrand Native Labor Association at the end of January was 5,176 greater than the number employed at the end of December. Of this increase, no fewer than 4,547 were obtained by the gold mines, bringing the total employed in the mining of the precious metal up to 193,063. The increase is being reflected in greater production and development, and, should it prove permanent, it will be of material assistance to some producers in carrying out their programs.

Secretary Work Denies Rehearing on Oil-Shale Lands

SECRETARY WORK of the Department of the Interior on Feb. 29 promulgated a decision in the Krushnic oil-shale case, affecting lands in Utah, Wyoming, and Colorado, denying motion for rehearing filed by the mineral claimant. The question involved is whether the applicant for a mineral location made on oil-shale lands prior to the enactment of the mineral leasing act, and the repeal of the general mining laws as to shale lands, can obtain a patent under the general mining laws, where he failed for one or more years to perform the annual assesment work upon the claim, a requirement under the mining law. It is contended by mineral applicants that the only penalty for failure to do this work would be relocation by some other citizen, and that this could not occur, in view of the repeal of the general mining laws affecting oil shale.

The government officials concerned held that in the event of failure to perform this annual assessment work the land reverted to the government and was only subject to disposition under the general leasing law. Secretary Work invites a legal proceeding to determine the question of law involved.

Giant Air Lift Being Used to Unwater Tiger-Poorman

WORK ON the unwatering of the Tiger-Poorman mine at Burke, in the Coeur d'Alene district, has been started. When it is completed, the workings of the once famous lead-silver property will be inspected and possibly restored to production. Hecla Mining, which has owned the property for several years, expects to mine zinc and possibly lead. The first step in the restoration of the old mine was taken about the middle of February, when a large air lift began discharging a 10-in. stream of water at the rate of 1,500 gal. a minute. Plans call for unwatering of the shaft down to the 600 level, and investigation of the workings down to that depth will then be made before continuing the unwatering.

The air lift consists of a column of 10-in. steel pipe, 720 ft. long, suspended in the shaft. Alongside are air-jet pipes, 2 and 3 in. in diameter, supported by heavy clamps from the main column. They are inserted into the 10-in. pipe at intervals of 180 ft. These jets extend upward in the main pipe several feet. Near the end they are perforated with quarter-inch holes, numbering from 150 to 250 to distribute the air as it enters the water. Guide shoes from the main column, 80 ft. apart, extend to the guide rails of the shaft. The column rests on a steel frame, within which is a 16-in sheave wheel and around which a cable, attached to a specially constructed "snubbing" hoist to raise or lower the apparatus, is passed. The entire weight of the air lift, 35 tons, is sustained by this cable. Compressed air is obtained from the compressor plant at the Hecla mine on the opposite side of the canyon. The air lift, by far the largest that has ever been used in the Coeur d'Alene district, was constructed in the Hecla shops under the direction of J. B. Sloan, master mechanic.

Old Argo Mill Adopts Flotation Process

The Quartz Hill Holding Company, of Denver, is actively engaged in remodeling the old Argo mill, at Idaho Springs, for flotation operation. Contract for the work has been let to the Hendrie-Bolthoff Manufacturing Company, of Denver, and is actively under way, with James N. Flood in charge. It is reported that a copper-lead separation is to be made at first, with rejection of pyrite and a little sphalerite.

Alaska Railway Shows Profit for December, 1927

Heavy Shipments of Dredging Machinery Help to Put Government Line in Credit Column for First Time

THE Department of the Interior announces a profit in the operation of the Alaska Railroad for the month of December, 1927, for the first time in its history, as reported in a letter from Noel W. Smith, General Manager, to the Secretary of the Interior dated Feb. 24, 1928, as follows:

"For the month of December, 1927, the revenue received by the Alaska Railroad, including the water line, was $5,619 more than the expense for that month; or, in other words, for the first month in its history, the Alaska Railroad has operated at a profit. As you understand, this is due to having very heavy shipments of dredge material in the month, and it is not a condition due to natural growth in the month of December.

"The deficiency for the first six months is approximately $165,000 less than for the first six months of the last fiscal year. However, the remaining six months of the fiscal year 1928 will probably not be able to make as favorable a showing as the last six months of the fiscal year 1927, due to the fact that we do not estimate that we will have as large a volume of freight business in those six months and our expenses in January and February have been heavier than last year, due to the fact that snow conditions have been much more severe all along the line this year than last.

"I find in reviewing the situation in Seattle that the prospects for freight business for the last six months this fiscal year are more favorable than I expected to find that they would be when I left Washington."

Hollinger Inquiry Marked by Conflicting Evidence

AN INQUIRY into the causes of the recent disaster at the Hollinger mine in which 39 men lost their lives was made at Timmins, Ont., during the week beginning Feb. 27 by the commission appointed for that purpose by the provincial government of Ontario. Much conflicting evidence has been presented, but the principal point brought out is that shift bosses, motormen, and transportation bosses knew of the practice of dumping refuse from underground powder houses in old stopes. Apparently very little attention was paid as to whether or not the refuse was diluted with waste rock, although the management assumed that this was done. According to evidence adduced, George Craig, the safety inspector employed by the mine, did not know of this practice. It also appears that he did not consider it part of his duties to inquire as to the disposition of the refuse, although he visited the magazine daily and recorded temperatures. The commission, headed by Justice T. E. Godson of the mining court of Ontario, is making an earnest effort to fix the responsibility for conditions, but because of the size of the Hollinger organization and the amount of extraneous evidence presented, it is having difficulty in accomplishing anything tangible.

As the first step toward the prevention of a recurrence of the tragedy, Thomas Sutherland, chief inspector of mines for Ontario, has issued a general order that all underground powder houses must be moved to the surface. This order applies to all mines, and has been transmitted to them by the various district inspectors. No time limit has been set for removal of the structures, but the order carries the intimation that the change be made as quickly as possible.

Silver Producers' Claims Against Government Presented

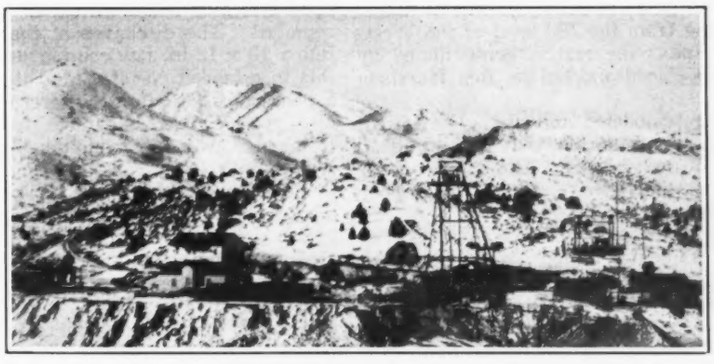
Testimony was taken at Aspen, Colo., in the suit of the American Silver Producers Association to compel the federal government to purchase 15,000,000 oz. of silver at $1 an ounce. This quantity of silver represents the amount needed to complete purchases under the Pittman Act. The association was represented at the hearing by George Thomas, and the government by Leo Rover, assistant to the district attorney for the District of Columbia. The purpose of the hearing was to prove definite sales by the association so as to support the claim for their interest in the suit, which has been denied by the government.

Consolidated M. & S. Not Interested in Pend Oreille

Northwest Lead-Zinc Company Is Not Associated With Any Other, President Declares

A RUMOR that the rise of Pend Oreille Lead & Zinc shares in a brief period from 50c. to $26.50 on Northwest exchanges was the result of acquisition of control of the company's stock by Consolidated Mining & Smelting Company of Canada has been denied by Lewis P. Larsen, president of Pend Oreille. The stock is now quoted at about $18. Mr. Larsen made it quite clear that his company is not associated with any other company. He did, however, admit that large Canadian interests have invested in Pend Oreille.

Pend Oreille owns a strip of land about two miles wide which extends 14 miles south from the international boundary, along the trend of the Pend d'Oreille River. This ground, according to Mr. Larsen, is to be extensively diamond-drilled. Work of exploration will be started as soon as the weather permits. Much of this territory is believed to contain large deposits of low-grade silver-lead-zinc ore. At present the company is operating a 200-ton mill on ore being taken out of the ground. It owns large potential power rights at Metaline Falls, which will be useful in further plant construction. If, as is expected, the results of the drilling prove satisfactory, between six and seven million dollars, mostly Canadian capital, will, according to report, be used in development and equipment of the property.



North Lily shaft in Tintic District

Work at Tintic Standard and North Lily Progresses

DEVELOPMENT work on the 800 level of North Lily in the Tintic district, Utah, has disclosed a body of high-grade ore. Discovery of the orebody was first made on the 700 level of the Tintic Standard mine, an adjoining property. It was then found to extend into North Lily property, in a continuous body from the 700 to 800 level. Recoverable values of lead and silver are said to be high. New machinery is being installed in the North Lily shaft, and operations are being carried on through the Tintic Standard. The accompanying illustration shows the North Lily shaft at present. A large hoist is being moved from the Gemini mine, and a new compressor has been ordered.

Tintic Standard has struck a new orebody on the 1,250 level, 1,000 ft. northwest of the No. 2 shaft. Drifting has disclosed about 260 ft. in length and a width of 40 ft. Development is proceeding on upper and lower levels to determine the size and shape of the orebody.

Mojave County Gold Mining Makes Progress

Sunnyside Development Discloses Good Orc—Leviathan Mill Treating 40 Tons a Day

GOLD mining in Mojave County, Ariz., is in good condition. Several of the high-grade strikes of the last year or two have developed into sizable orebodies, and this has increased development activities in the district. In the Sunnyside mine, at Oatman, a winze has been sunk on the vein to a depth of 100 ft. below the 535 level. At the bottom of the winze the ore assayed fairly high. At a distance of 35 ft. from the winze, the east drift on the 635 level, it is reported that samples assay about $62 per ton in gold. The vein in places is as wide as the drift, it is said. Boss Gold Mining, whose property lies southwest of the Sunnyside, has started to drift toward the Lucky Bill vein, on the Boss property, from the 535 level of the Sunnyside. Oatman Eastern is driving east from Sunnyside shaft No. 1 and is reported to have struck ore in the Argo property, which it has under lease. United American, whose property is also near the Sunnyside, has issued 2,000,000 new shares of stock, which it plans to sell at 10c. Proceeds will be used to purchase a double-drum electric hoist and a compressor. The shaft will be deepened and development will be undertaken at new and lower levels.

Gold Ore is crosscutting from the bottom of its new 300-ft. shaft on the Brooks property and has nearly reached the vein. The new 1,000-ft. shaft which this company is sinking on the Tom Reed has been timbered to a depth of 260 ft. Tom Reed mill is treating 100 tons of gold ore daily; 60 tons of this is coming from the 700 level of the Western Apex; the rest is being mined by the Goldroad and on the Ben Harrison lease.

The remodeled mill at the Leviathan mine, near Chloride, is now treating 40 tons of ore per day. The chief concentrate is molybdenite, but a little copper concentrate is also made.

At the Katherine mine, 280 tons of ore is being milled daily from the 200, 300, 400, and 500 levels. A heavy flow of water was encountered on the 900 level some months ago, and as a result all workings below the 600 level were flooded. The water is now rapidly lowering, and as soon as possible development will be resumed on the 900 level.

All copper ore stopes in the Czar and Southwest mines, the oldest workings in the Bisbee district, are to be abandoned, according to an announcement made by J. P. Hodgson, manager of the Copper Queen branch of Phelps Dodge Corporation. Lead-producing sections of these mines will continue in operation. There will be no reduction in working force, as the men from the abandoned sections will be moved to the Gardner Lowell and Sacramento divisions. Curtailment of operations at the Czar and Southwest mines was decided on because no commercial copper orebodies have been discovered recently, although the usual exploration work was done. About 250 men will be transferred.

As a result of the finding of the new orebody on the 2,000 level of the Denn mine, at Bisbee, Shattuck Denn is preparing to install a new electric hoist and to do a large amount of development. Ore from the 2,000 level is hoisted to surface by two stages; a small hoist lifts it to the 1,800 level, and from there the main hoist carries it to surface. It is planned to sink the shaft an additional 100 or 200 ft., to drive exploration drifts in the territory below the 2,000 level. Thomas Bardon, of New York; A. M. Chisholm, of Duluth; and B. M. Pattison, of Los Angeles, directors of the company, have recently visited the mine to plan further developments. Mr. Pattison was formerly mine superintendent at the Denn property. The work will cost about $100,000.

Treadwell Yukon Completing Mill in Sudbury District

TREADWELL YUKON Mining is rapidly completing its initial milling plant of 200-ton capacity in the Sudbury district of Ontario, and expects the plant to be in operation by the first of next month. The plant is to be used for experimental purposes until complete operating details are determined, when it will be placed on production. The mill was designed by Lloyd C. White. Its principal features are as follows:

Ore is discharged from mine cars to a conveyor belt and delivered to a storage bin. It is then fed to a trommel screen, the oversize being discharged upon a picking belt from which waste is removed. The discharge of the belt is into a 10 x 12-in. jaw crusher and from this to a bucket elevator, and thence to a ⅜-in. Link-Belt vibrating screen, which also receives the undersize from the trommel. Oversize from the screen is sent to 36 x 16-in. rolls and returned to the bucket elevator. Screen undersize is discharged to a belt conveyor and after going over a "weightometer" is delivered to a bin. Roll-type feeders discharge the fine ore into Allis-Chalmers ball mills and these in turn discharge into 6 x 25-ft. Dorr classifiers in closed circuit with the ball mills. Finished size is delivered to a 20-ft. Dorr thickener, the underflow of which is sent to the flotation department.

It is planned to separate first a copper-lead concentrate and then to float the zinc concentrate. The copper-lead concentrate is separately treated, the copper sulphides being depressed and the lead sulphides floated. Three concentrate products are to be made. Details of the flotation circuit will be worked out during the experimental period. Mineral Separation machines are to be used in the primary circuits and Hearing cells of the pneumatic type for cleaning.

The company has completed its No. 2 shaft to a depth of 500 ft. and is now opening out a level at this point.

Royal Tiger Enlarges Holdings

Company Is Now Operating Three Shifts—New Ball Mill Being Installed

THE Royal Tiger Mines Company, operating in Summit County, Colo., has acquired the total holdings of the Tonopah Placers Company, including its dredge and machine shop in Breckenridge, Colo. Total holdings of the company in the Swan River and Breckenridge districts are now more than 8,000 acres. At South Tiger, which is 3 miles up French Gulch from Breckenridge, operations on a small scale are carried on, and some leasing is being done on the old Lucky, Minnie, and Ella mines. The company's principal operations are confined to work on the old Royal Tiger mines, the I X L mines, and the Cashier mines at Tiger, which is 8½ miles from Breckenridge and 4 miles from Braddocks, on the South Fork branch of the Colorado & Southern Railroad. At Tiger, on the Swan River, the old Royal Tiger mine and the Cashier mine are connected through a tunnel approximately one mile long, and ores are being taken from points generally throughout the area.

The ore deposits consist of a mass formation of zinc-lead ores in quartz-monzonite porphyry. Near the surface, particularly in the Cashier mines, the oxidized area carries good values in free-milling gold ore. A small amount of gold and silver is found throughout all the ores at Tiger, in both the Tiger mines and the Cashier mines.

Fourteen thousand tons of the zinc-lead ore were put through a testing plant from general development work, primarily to determine the values of the ores, their association, and the proper method of treatment. A 600-ton testing plant on zinc-lead ores has been in operation for several years, making these test runs. The drop in the price of zinc and lead determined the company against any further processing of its zinc-lead ores, and its entire attention now is devoted to the treatment of its gold ores, which necessitated a decided change in the milling process. The mill is operating three shifts on its gold ores. The crushing equipment, consisting of 24-in. jaw crusher and three sets of rolls, reduces the ores to 2 mm. Launder riffling and coarse gold traps, very simliar to the methods used in placer mining, are in use for the trapping of the coarser wire gold. A part of this product is reground in a 5x5 ball mill, amalgamation following the ball mill crushing and the primary fines. A 6x6 ball mill should be in operation soon. An 8x10 ball mill is being installed.

Mr. O. N. Bribach is not now, nor has he been at any previous time, in charge of metallurgical processing as reported in *E. & M. J.* of Feb. 18. Also, the mill capacity is not 50 tons per day, according to John A. Traylor, president of the Royal Tiger, who courteously directs attention to the inaccuracies in the former news report.

Lode and Placer Mining in Lemhi County, Idaho, to Expand

LEMHI COUNTY, Idaho, mines face a season of brisk activity. Both lode and placer mines will be the scene of intensive operations. Gilmore district silver-lead mines are now leading in production. About 50 carloads of ore is being shipped monthly to Utah smelters. The Pope Shenon mine recently shipped a carload of high-grade copper concentrate. The Gold Ore Mines, an Idaho syndicate, is operating the Queen of the Hills mine and building a reduction mill at the Silver Star mine, near Salmon City.

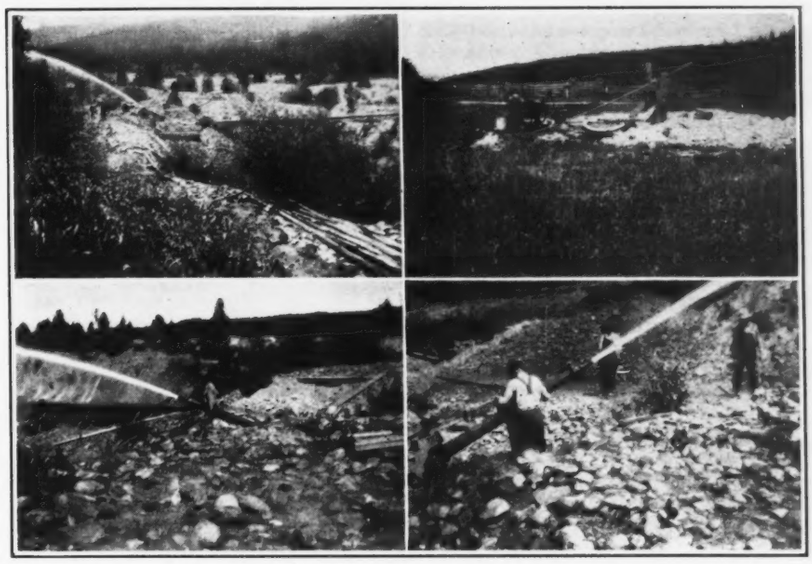
At Leesburg, Bonanza Placers has spent $40,000 equipping its hydraulic mines with pipe lines, several miles of ditch, and a sawmill, preparatory to operating three hydraulic giants during the 1928 season.

Seven miles north of Leesburg, H. F. Byram has a ten-year bond and lease on the famous McNutt gold placers, on Moose Creek. Last season Mr. Byram employed fifteen men digging ditches, building a mile of flume, laying a pipe line, and preparing the property for extensive placer operation, to begin as soon as the spring thaw sets in. Mr. Byram, according to present plans, will operate two hydraulics.

The property is owned by John E. Mullen, of Salmon, Idaho. It consists of 354 acres of placer ground. About 50 acres of this has been mined by hydraulic methods, with a record of production of over $1,000,000. A lesser acreage has been dredged and produced about $500,000, the dredge used being capable of handling less than 500 yd. each 24 hours. This dredge was in operation until about 1917, when it was wrecked. It has not been rebuilt. It was then practically worn out and antiquated in design, having been in operation continuously for fifteen years or more, except when tied up for repairs and during the winter. Mr. Mullen, the owner of the ground, acquired the dredge and property in 1906 from the Pacific Dredging Company.

Operation of the property covers a period of nearly 60 years. For a small acreage, its production has been notable. Another interesting fact is that over a large part of the property lignite underlies the auriferous gravel. This lignite is of such grade that it is used for fuel in the camp, and was even used successfully in the operation of the dredge.

On Nippias Creek, east of Leesburg, a Montana company has several carloads of hydraulic equipment ready for operation as soon as spring begins.



Upper left—Old workings at McNutt placer. Upper right—Virgin ground, showing prospect hole. Lower left—At the outlet end of sluice boxes. Lower right—Hydraulic giant in operation

Calico District Property to Be Explored

TITLE to Waterloo Mining's former holdings in the Calico district, California, long ago an important silver-mining center, has been acquired by O. F. Washburn and associates. It is reported that the new owners will explore to greater depth.

Key West Mining is reported to be rehabilitating the Key West mine, near Bunkerville, Clark County, Nev. A 50-ton unit of a 150-ton flotation mill is being erected and is expected to be placed in operation in the near future. Platinum was reported in the ores from this property, a number of years ago. Louis Thompson is president of the company and H. Sills, superintendent.

Butte Boys Consolidated Mining has been formed to take over the Butte Boys prospect in the Goldfield, Nev., district and the Crown Peak claims near Coulterville, Mariposa County, Calif. Exploration work is to be started at both properties.

At the Roosevelt property, near Hamilton, Nev., W. B. Bierce has erected a 50-ton mill. Two tables have been operated and silver-lead concentrates produced. Other equipment is to be added.

An option to purchase the Peerless group of claims in the Centerville mining district, west of Redding, Calif., has been taken by N. W. Bowen.

The Dutton placer property on Dutton Creek below Douglas City, Trinity County, Calif., has been acquired by E. D. Westbrook.

Aladdin Divide is reported to have acquired the Cliff prospect near Portola, Calif. A crosscut tunnel is to be driven to explore surface ledges. J. F. Cowan is manager for the company.

Ontario Graphite Mill Destroyed by Fire

The refining mill of the Black Donald Graphite Company, Ltd., 14 miles west of Calabogie, Renfrew County, Ont., and other buildings at the mine were destroyed by fire on the night of Feb. 28, entailing a loss estimated at $100,000. The fire did not enter the mine proper, as the mill is situated about 100 ft. from the mouth of the two main shafts.

Black Donald is the largest graphite mine in the world. It employs 200 men, who will be thrown out of work until the refining plant and boiler room are rebuilt. It is expected that this work will require several months.

State of Texas to Sue Sulphur Producers

LEGAL STEPS for the collection of more than one million dollars of gross receipt taxes from the Freeport Sulphur Company and the Texas Gulf Sulphur will be taken by Claude Pollard, Attorney General of Texas.

According to the letter transmitted by Comptroller Terrell to Attorney General Pollard, the two companies "control the world's supply of the product and produce 80 per cent of the world's production. At present the world's consumption is estimated at 2,000,000 tons annually. From June 14, 1923, to and including July 1, 1927, the two sulphur companies have remitted the 2 per cent tax on long tons produced, computed on a market value of $10 per ton, and in each report and remittance they have paid the tax under protest, contending that the law is illegal, and therefore void."

Claim is made that for the period beginning June 14, 1923, and ending Dec. 31, 1927, Freeport Sulphur owes the state $508,688, which includes the unpaid tax, penalty, and interest. For the same period, the audited report shows that Texas Gulf Sulphur owes the state $581,149.

London Letter

By W. A. Doman
Special Correspondent

Consolidations Forecast as Slump in Tin Price Continues

London, Feb. 21, 1928.—No improvement can yet be reported in the tin position. There is plenty of hope, but it is quoted as "Hope deferred." Cornish mining companies are complaining that they will be driven into bankruptcy if the price is not stabilized. Elimination of speculation is strongly urged. In other quarters it is suggested that small companies should combine to form big corporations, and that agreements with the smelting interests should then be drawn up. The Anglo-Oriental Corporation has been formed with a capital of £1,500,000 in 1,200,000 preferred shares of £1 and a like number of 5s. ordinary shares. This corporation, it is reported, may acquire Far Eastern tin mining areas now controlled from Australia.

The office of the European Zinc Cartel will be established at Brussels. A common statistical bureau will receive reports regularly on production and stocks from members, and will furnish all information necessary.

A private company has been registered with the title of the Anglo-Serbian Mining Company, Ltd., with a nominal capital of £10,000, to acquire and turn to account any mines, mining rights, and metalliferous lands in the Kingdom of the Serbs, Croats and Slovenes, or elsewhere, and to work deposits of various minerals in southern Serbia.

It is reported that the new works under construction at Marghera, Italy, will satisfy all of Italy's aluminum requirements.

A CONFERENCE of European producers of synthetic nitrate has been fixed to take place from April 30 to May 8 in the Mediterranean. Those taking part in it are the Comptoir Français de l'Azote, Montecatini, Nitram, Ltd., the Norwegian Company of Azote, and the German cartel. The object of the conference is to examine the general situation of fertilizers in agriculture. Producers of Chilean nitrate were not at first asked to attend, but have since received invitations. Stocks of Chilean nitrate in France at the end of January amounted to 229,000 tons. The stocks have been collected with the object of covering the needs of French agriculture for the coming spring.

Some comment is being made on the fact that P. K. Horner has so greatly modified his views concerning the copper properties of Southern Rhodesia Base Metals. At one time he estimated there were about 19,000,000 tons of ore to be worked. His latest estimate is about 4,000,000 tons. Both Copper Queen and Copper King show a substantial quantity of low-grade ores, which may be made to yield profits, provided treatment is conducted on a large scale, that developments in the sulphide zone are as anticipated, and that power, labor and transport are available.

Mr. Horner also recently visited the Luiri Gold Areas in the western part of the concession held by Rhodesia Minerals Concession, Ltd., in Northern Rhodesia. About thirty discoveries have been made to date. Little work, however, has been done on them so far, though some show appreciable values and possibilities. A company has consequently been formed called Luiri Gold Areas, Ltd., with a share capital of £60,000 in 5s. shares, of which 120,000 are priority and 120,000 ordinary shares. The company will acquire the areas from Rhodesia Minerals Concession, and Loangwa Concessions.

Wyoming Shows Symptoms of Mining Revival

REPORTS from Wyoming indicate that the mining industry of the state is gradually increasing in importance. A number of small properties have been reopened, new machinery is being installed, and, in one or two operations, mills are being constructed.

Wyoming Mining & Milling is reopening the Miner's Delight, a property in the South Pass district near Atlantic City, Wyo. This mine was first opened in 1867 and is reputed to have produced $1,000,000 worth of gold. Material thrown into the dump is to be treated by new processes, as it is believed that much ore was thrown away containing quantities of gold that can be extracted by modern methods.

Last year, Wyoming, for the first time since 1923, had a small non-ferrous metal production. This promises to be considerably increased during the present year. Last year's production was in gold and platinum.

In addition to this non-ferrous metal mining, Wyoming produces quantities of asbestos, building clays, gypsum, mineral pigments for paints, bentonite, limestone, oil and oil shale, and iron ore.

Promoter Sentenced for Fraud

Charles H. Manaton of Toronto, former secretary and manager of the West Dome Lake Mines, Ltd., who was convicted of issuing false statements with the intent to deceive and defraud, was sentenced by Judge Denton on Feb. 29 to twelve months in the Ontario reformatory with an additional indeterminate period not to exceed six months. The judge stated that in fixing the sentence the jury's recommendation for mercy had been carefully taken into consideration. Though regretting the position in which the prisoner found himself, it was necessary that a substantial sentence should be imposed, as a warning to persons operating illegally in the mining business.

Mexico City Letter

By W. L. Vail
Special Correspondent

Next Mexican Congress to Consider Revision of Labor Laws

Mexico City, Feb. 24, 1928.—The national mining chamber, together with a number of industrial interests, is working on a substitute for the new labor law which is to be proposed again at the next session of the Mexican Congress. It is understood that the Obregon bloc will insist on this law, which was proposed at the last session, only to be chloroformed in the Senate. Labor legislation put into successful operation in other countries is embodied in the substitute being prepared by the mining chamber. Most of the large mining corporations have solved their labor problems fairly well by now and fail to see the need for further legislation.

Regulations on the purchase, sale, and transportation of explosives are the subject of a handbook issued by the war department to all of the principal mining companies. It would appear that the department wishes to remove unnecessary red tape, so that responsible concerns will have little annoyance in handling explosive.

In addition to the federal tax of 3 centavos a liter of gasoline for the building and maintenance of roads throughout the republic, the State of Chihuahua has added another centavo, promising that the funds realized from this tax will be devoted exclusively to road building. As the construction of roads is of vital importance to the mining industry, there seems to be no particular opposition to the new impost from mining interests.

A LOAN of 5,000,000 pesos to the federal government has been partly financed by mining interests. It is supposed to be a temporary arrangement to cover small obligations until a loan of some magnitude can be negotiated.

Peñoles is diamond drilling at its Ojuelas property, Durango. It is expected that the company will have to drill some 1,200 ft. before reaching the orebody. Present plans call for the expenditure of 3,000,000 pesos on development and exploration during the next two years.

New machinery is being installed for operating the properties owned by the Ambrosius brothers in Guanacevi, Durango. They have been actively worked for some years and constitute the chief operation in the district.

A company recently organized in Los Angeles is preparing to take up a number of mining properties in Nayarit, near the Southern Pacific extension from Mazatlan to Guadalajara. A number of denouncements of gold prospects have been made in the vicinity since the first of the year.

Book Reviews

The Laboratory

TECHNICAL METHODS OF ORE ANALYSIS. By Albert H. Low. Tenth edition. Pp. 348. John Wiley & Sons, Inc., New York, 1927. Price $3.50.

FOR nearly fifty years the author of this book has been identified with the metallurgical laboratories of Colorado, and since its appearance in 1901 the work has been widely used by Western chemists. Fifteen thousand copies have been printed, and the present tenth edition contains about 50 per cent more matter than the first.

Excluding gold and silver, the book covers the determination of the ordinary metals and non-metals in ores, such metals as uranium and vanadium being fully treated; alloys of several classes; crude petroleum, oil shale, coal, coke, and boiler water are also included. For most of the metals several alternate methods are described. For instance, under copper, the author gives first place to the iodide method, followed by the electrolytic, cyanide and colorimetric; but omits all procedures based on precipitation of cuprous thiocyanate. The chromate method given for lead is the one which utilizes the iodide-thiosulphate end point; the molybdate, oxalate-permanganate, and ferrocyanide methods are also included. No method of estimating carbonate is given, even in connection with limestone or water. The preparation of the Witt plate is fully described in the general instructions, but not of the Gooch crucible, though the latter is several times recommended in the text. Predilection for the bisulphate fusion as a means of attack is evident.

The main feature of the book is the close attention paid to the practical details of procedure, while in many cases the equations involved are to be found in appended notes. One brief but useful chapter deals with the combination of determinations, often a source of trouble to beginners.

W. J. SHARWOOD.

"GASES, DUST AND HEAT IN MINES." By K. Neville Moss. Charles Griffin & Company, Ltd., London. J. B. Lippincott Company, Philadelphia. Pp. 233.

INTERESTING practical data have been brought together in this up-to-date book. The object of the author is to summarize the existing information on gases, dust, and heat in underground workings and to indicate its value to the mining engineer. The work, in its treatment, presupposes a knowledge of mathematics, physics, and chemistry, but, as the author states, the purely mathematical part may quite well be omitted by the reader without serious detraction from the value of the book as a whole.

Part I deals with "Mine Gases and Dusts"; Part II with "The Physics of the Atmosphere"; and Part III with "High Air Temperatures in Mines."

The first chapter of Part I discusses in a general way the subject of the air of mines. Succeeding chapters deal respectively with firedamp, carbon monoxide, and other gases such as hydrogen sulphide, nitrogen tetroxide, and afterdamp. The last chapter of the first section is devoted to the subject of dust.

Part II is divided into four chapters, dealing respectively with the subject of pressure and temperature, thermodynamics and specific heat, humidity and velocity, and heat transfer.

Part II is a necessary preliminary to Part III, which deals with high air temperatures underground. Their ill effects and practical aspects are discussed and methods of conditioning mine air are described. The last chapter is devoted to a discussion of ankylostomiasis, or hookworm disease. This disease is not uncommon in hot and humid mines, and for this reason is considered by the author.

SCIENCE — The McGraw-Hill Book Company is undertaking to launch a new series of scientific books, to be known as the "Frontiers of Science Series," which will cover the entire circle of the sciences. It is planned that the volumes will be revised, rewritten, or replaced by new as frequently as the advance of investigation requires. The series therefore should always be complete and up to date. The publishers will be assisted in the selection of authors and topics by the trustees and editorial staff of Science Service of Washington.

A NEW ATLAS—C. S. Hammond & Co., Inc., 30 Church St., New York, N. Y., announce an atlas which they style "New World Loose Leaf Atlas." This atlas is, in reality, the publishers state, a collection of maps held firmly together by a loose-leaf binder from which individual maps when they become obsolete may be removed and replaced by new ones. The publishers undertake to keep this atlas revised up to Jan. 1, 1930, through the medium of three additional installments of correction sheets.

MINE TEMPERATURE — The *Queensland Government Mining Journal* for Dec. 15, 1927, contains an article entitled "Temperature in Deep Mines," by F. Jansen. This is a translation from *Glückauf*.

COPPER, AUSTRALIA—The same issue of the Queensland *Journal* contains a short article entitled "Copper Industry in Australia" in which the recommendations of the Commonwealth's tariff board are set forth.

ONTARIO MINING—The Thirty-sixth Annual Report of the Ontario Department of Mines has been received. It contains three articles, as follows: "Geology of the Basin of Red Lake, District of Kenora (Patricia Portion)," by E. L. Bruce and J. E. Hawley; "Gammon River Area and Rickaby Lake Schist Belt, District of Kenora (Patricia Portion)," by Geoffrey Gilbert; and "Woman and Narrow Lakes Area, District of Kenora (Patricia Portion)," by J. W. Greig. The report comprises 120 pages, with several loose maps.

IDAHO GEOLOGY—Professional Paper 152, issued by the U. S. Geological Survey, is entitled "Geography, Geology, and Mineral Resources of Southeastern Idaho." The authors are George Rogers Mansfield and G. H. Girty. The paper comprises 453 pages. The area covered comprises approximately 2,200 square miles in the southeast corner of the state, with narrow adjoining strips of Utah and Wyoming. Part of the Western phosphate reserve is included in this area.

TIN—The Mitate tin mine, Kiushiu, Japan, is described by A. R. Weigall in the January issue of *The Mining Magazine*, London. A considerable tonnage of ore ranging from 1.82 to 2.20 per cent is reported to have been opened up. The same issue contains an illustrated article entitled "Tin Saving on Dredges," by F. W. Payne.

FLOTATION — The January *Mining Magazine* also prints a contribution from Bernard W. Holman, Royal School of Mines, on "Flotation Practice in Canada." Professor Holman comments on differential flotation and discusses the flotation practice met with last summer during the tour of the Empire Mining Congress in Canada.

SURVEYING—L. H. Cooke, professor of mine surveying at the Royal School of Mines, is likewise a contributer to the January issue of the London publication. He writes on "Precise Magnetic Orientation in the Ore Mines of Great Britain."

MANGANESE—Lulletin 795-H of the U. S. Geological Survey is entitled "A Manganese Deposit of Pleistocene Age in Bannock County, Idaho." Ten pages.

The world manganese situation in 1927 is reviewed in *Commerce Reports* for Feb. 6.

CAVING—The *Dupont Magazine* for January publishes an article entitled "Caving System of Mining Low-grade Ores as Practiced at Juneau, Alaska." The author is J. A. Williams, chief engineer of the Alaska Juneau company.

ZINC — The monthly bulletin (*Zn*) of the American Zinc Institute contains an article entitled "Factors Affecting the Marketing of Tri-State Zinc Concentrates," reprinted from the *Harvard Business Review*. The author is M. D. Orten.

LIMESTONE—Technologic Paper No. 349. U. S. Bureau of Standards, Washington, "Physical Properties of the Principal Commercial Limestone Used for Building Construction in the United States" by D. W. Kessler and W. H. Sligh. Contains 94 pages. Price 30c.*

This paper is devoted mainly to the physical properties of the limestones used in this country for building purposes. Determinations of the strength of these materials in compression, flexure and shear have been made as well as a few measurements of tensile strength. In general, these properties were determined both perpendicular and parallel to the bedding. Compressive strengths have been determined also in the wet and dried conditions. Impact and permeability tests as well as elasticity measurements have also been made.

FLOTATION—An article entitled "Testing Ores by Flotation" is running in the *South African Mining and Engineering Journal*, beginning in the Jan. 7, 1928, issue. The author is Bernard W. Holman of the Royal School of Mines, London.

"FIRE SETTING"—*The Mining and Industrial Magazine of South Africa* in its issue of Jan. 25 contains a short article entitled "Mining by Fire at the New Modder." It describes an effort to use the flame thrower, developed during the war, for breaking rock underground.

VIRGINIA GEOLOGY—Bulletin 30 of the Virginia Geological Survey is entitled "Geology of the Gold-Pyrite Belt of the Northeastern Piedmont Virginia." The author is John T. Lonsdale. One hundred and ten pages.

ASBESTOS—R. C. Roe is the author of an article entitled "The Bell Asbestos Mine at Thetford Mines, Quebec," which appears in the Feb. 17 issue of the *Canadian Mining Journal*. Six pages.

GOLD IN ONTARIO—The *Canadian Mining and Metallurgical Bulletin* for February contains an article entitled "The Wide Dissemination of Gold in Northern Ontario," by H. C. Boydell.

DUTCH GUIANA—*Mining and Metallurgy* for February contains a three-page article on the mineral industry of Dutch Guiana, by E. A. Kilinski, geologist of Caracas, Venezuela.

UTAH GEOLOGY—Another of the Survey's Professional Papers (No. 150-C) is "A Section of the Kaibab Limestone in Kaibab Gulch, Utah," by L. F. Noble. Twenty pages.

LIME BURNING—The Feb. 18 issue of *Rock Products* contains the second installment of the article on "Lime Burning Practice," by Victor J. Azbe, St. Louis.

MANITOBA GEOLOGY—The same issue of the *Bulletin* contains an article entitled "Copper-Zinc and Gold Mineralization in Manitoba," by R. C. Wallace.

*Sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C.

BRADEN COPPER—*Metall und Erz*, Jan. 2, 1928, contains an eight-page article by J. Kuntz on El Teniente mine of the Braden Copper Company.

KATANGA—The February issue of *Metall und Erz* contains an article entitled "The Katanga Copper Country" by Franz Kroll, Brussels.

PATENTS

COPPER—No. 1,657,097. Jan. 24, 1928. W. C. Tracy, Los Angeles.

An apparatus for recovering copper from its ores, consisting of a tank having a flat horizontal coil on the bottom; also a number of oppositely diverging perforations; also a helical coil around the inner periphery of the tank, which coil has perforations for emitting air currents transversely across the tank; also a means for supplying compressed air to the coils.

CRUSHER—1,656,895. Jan. 24, 1928. Hugo Ackermann and Wilhelm Langenheim, Germany.

A conical crushing mill including a conical crushing mantle, a shaft and a seating element fixed to the shaft, the space between mantle and seating element being filled with hard lead. The heating element is stepped, one or more of these steps being under-cut.

SULPHUR. No. 1,657,545. Jan. 31, 1928. Henry F. Merriam, assignor to General Chemical Company, New York.

A process of burning sulphur, comprising the step of periodically draining off a portion of the melted sulphur containing concentrated impurities when these have been concentrated to a predetermined value.

METALLURGY. 1,657,622. Jan. 31, 1928. Donald F. Hare, assignor to International Reduction Company, Denver.

A method of treating finely ground ore by roasting in the presence of appropriate reagent matter under certain conditions of air supply for the purpose of more effectively converting metalliferous matter contained to a soluble state during the roasting.

FLOTATION. No. 1,657,666. Jan. 31, 1928. Risdale Ellis, Oak Park, Ill.

A process of concentrating copper ore containing leachable copper by flotation, after dissolving such leachable copper and precipitating it in free metallic form with sponge iron.

ROCK DRILL—1,657,317. Jan. 24, 1928. H. S. Potter, Johannesburg, South Africa.

Certain features in a hammer rock drill.

ROCK DRILL—No. 1,657,339. Jan. 24, 1928. Cecil R. Anderson, Pittsburgh.

A hand-operated mine drill of the auger type.

ROCK DRILL. No. 1,657,597. Jan. 31, 1928. E. F. Terry, Jr., assignor to Denver Rock Drill Manufacturing Company.

A method of forming lubricators for rock drills.

CONDITIONING AIR. No. 1,658,114. Feb. 7, 1928. Karl Brunzel, Coblenz, Germany.

A means for drying air in mines comprising a closed receptacle having hinged end walls and containing a series of detachable perforated plates, the purpose of which is to hold water-absorbing substances.

FLOTATION. No. 1,659,396. Feb. 14, 1928. W. A. Douglass, Penns Grove, N. J., assignor to E. I du Pont de Nemours & Co., Wilmington, Del.

In a flotation process, the step which comprises subjecting the ore pulp to froth flotation in the presence of an organic derivative of trithio carbonate.

SULPHUR. No. 1,657,711. M. F. Coolbaugh and J. B. Read, Golden, Colo., assignor to the Complex Ores Recoveries Company, Denver.

A process of desulphurizing metalliferous sulphide material in a multistage roasting operation.

CYANIDATION. No. 1,658,249. Feb. 7, 1928. S. B. McCluskey, Fresnillo, Mexico.

The process of mixing cyanide with the pulp, acidifying the same, collecting evolved gases, precipitating the cyanicides and then reintroducing the gases.

CONCENTRATION. No. 1,658,874. Feb. 14, 1928. Thomas W. Ainlay, Farnam, Neb.

A centrifugal separator, comprising a revoluble bowl having a value retaining means on its inner face, and other features.

ZIRCONIUM. No. 1,658,807. Feb. 14, 1928. Charles J. Kinzie, assignor to Titanium Alloy Manufacturing Company, New York, N. Y.

A process of making zirconium compounds from a siliceous zirconium ore.

DYNAMITE. No. 1,658,816. Feb. 14, 1928. Carl D. Pratt, Tamaqua, Pa., assignor to Atlas Powder Company, Wilmington, Del.

A dynamite containing dried beet pulp as a combustible ingredient.

GREENSAND. No. 1,657,700. Jan. 31, 1928. Arthur C. Spencer, assignor to the Permutit Company, New York.

A process of modifying glauconite by baking and afterwards treating it with an alkali.

AUTOMATIC DRILLING. No. 1,658,262. Feb. 7, 1928. R. A. Sperry, S. J. Dickey, and J. A. Zublin, assignors to General Petroleum Corporation of California.

A means for drilling wells automatically by the rotary method.

TUNNEL KILN. No. 1,658,331-2-3. Feb. 7, 1928. W. L. Hanley, Jr., Bradford, Pa.

ROCK DRILL. No. 1,658,330. Feb. 7, 1928. George H. Gilman, Boston.

ROCK DRILL. No. 1,659,138-9. Feb. 14, 1928. George H. Gilman, Boston.

Certain features of hammer drills.

FURNACE—No. 1,657,401. Jan. 24, 1928. Julian Kennedy, Pittsburgh.

A method of operating a reversing furnace and its regenerators.

Personal Notes

B. W. KNOWLES, mining engineer, has returned to British Columbia from Denver.

A. C. DAMAN, president of the Denver Equipment Company, is in New York on business.

W. L. PENICK, Western manager of the Hardinge Company, is in Los Angeles at present.

C. L. BAKER, manager of Mexican smelters for the A. S. & R., is in New York on company business.

C. T. VAN WINKLE, Salt Lake consulting engineer, is making a mine examination at Nogales, Ariz.

ARCHER E. WHEELER, consulting metallurgical engineer, recently left for Russia, where he expects to stay three months.

J. C. MACGREGOR has accepted a position as geologist with Mandy mines, operating in the The Pas district of Manitoba.

R. C. WARRINER, at one time general manager of Crown Mines, recently returned to the Rand with Mrs. Warriner for a visit.

J. H. CURLE, author of "Today and Tomorrow," "Gold Mines of the World," and other works, recently visited Johannesburg.

M. C. H. LITTLE, manager of Keeley Silver Mines for the last four years, has resigned his position. He plans to enter consulting work at Haileybury, Ont.

WALTER J. CHILDERS, of Los Angeles, has been appointed general superintendent of the B and B Quicksilver Company at Arlemont, Esmeralda County, Nev.

E. E. BARKER, mining engineer with Utah Copper, recently left Salt Lake City on a leave of absence. Mr. Barker's headquarters will be in New York City.

J. HENDERSON has been appointed director of the Geological Survey Branch of the New Zealand Scientific and Industrial Research Department. He succeeds the late P. G. Morgan.

A. C. H. GERHARDI, general manager for the Toric Mines Company, Ltd., operating in the Alice Arm district in British Columbia, is in New York, on his way back to the mine after a visit in London.

C. E. CHAFFIN, of the General Engineering Company's staff, has gone to Winnipeg to take charge of the designs of the Flin Flon concentrator of the Hudson Bay Mining & Smelting Company, Ltd., for his company.

CARL ERICKSON, formerly of the Potter-Doal and the Amulet, is in charge of operations at the Cambro-Kirkland mines, in the Kirkland Lake area of northern Ontario, where shaft sinking will be immediately started.

FRANK LORING has been appointed consulting engineer of the Haslat Duck Lake Mines, Ltd., which has taken over from the Harrison syndicate a gold-copper property at Duck Lake, near Schreiber, in northern Ontario.

R. H. BARNUM, a prospector in northern Ontario and Quebec, is engaged in developing the holdings of the Norrington Development Company in the Thunder Bay district of Ontario. The properties were discovered by Mr. Barnum.

WILLIAM SLOAN, minister of mines for British Columbia since 1916, died on March 2 in Victoria. Mr. Sloan collapsed suddenly while attending a theater. He was 61 years old. A detailed biography of Mr. Sloan appeared in the July 10, 1920, issue of *Engineering and Mining Journal*.

WILLIAM SLOAN

HOWARD R. WARD, until lately mining engineer with Warren Foundry & Pipe Corporation, is leaving the United States soon for Numea, New Caledonia. He expects to stay in New Caledonia for two or three years, investigating chrome ore possibilities.

ARTHUR E. BENDELARI was recently elected president of Eagle-Picher Lead. Mr. Bendelari first joined the company in 1917, when he was put in charge of the operations in Ottawa County, Okla. A few years ago he was made vice-president with headquarters in Chicago.

THOMAS VARLEY, consulting metallurgist of Salt Lake City, has been in New York. Mr. Varley, who until recently was in charge of the Salt Lake Experiment Station of the U. S. Bureau of Mines, is the author of "Consumption of Reagents Used in Flotation, 1926," which has just been published by the bureau.

JAMES E. MOORE has been retained by Benguet Consolidated Mining, which is developing gold prospects in the Philippine Islands. Mr. Moore recently returned from Durango, Mexico, where he examined mine properties. Mr. Moore's address is now Benguet Consolidated Mining Company, Baguio, Benguet, P. I.

A. F. BEASLEY, assistant superintendent of the Bunker Hill smelter at Kellog, Idaho, since 1917, has been appointed superintendent to succeed the late M. H. SULLIVAN. At the same time, P. C. FEDDERSON and J. B. SCHUETENHELM, metallurgical engineers at the Bunker Hill plant, have been advanced to assistant superintendents.

D. ELLIOTT ALVES, chairman of the Panama Corporation, is leaving this week for the corporation's property, and will pay special attention to Cana, for which £50,000 has been privately subscribed. Two expert dredging authorities are accompanying Mr. Alves in order to investigate the alluvial properties that have been located.

SIR EDGEWORTH DAVID, the eminent Australian geologist, after spending about two years in England, returned to Sydney, Australia, early last December. Sir Edgeworth is one of the research committee appointed by the Earl of Balfour a few months ago to inquire into the application of geophysical methods to the discovery of mineral deposits such as have proved successful in Rhodesia and experiments in which are to be conducted in Australia under the guidance of BROUGHTON EDGE.

R. E. PALMER, who has just been elected president of the British Institute of Mining and Metallurgy for 1928, is a Canadian by birth. He received the degree of B.S. in 1887. From this date until 1900 he practiced his profession in the United States and British Columbia. For fourteen years, until 1914, Mr. Palmer took charge of the underground mining operations of the Rio Tinto company. He then returned to London, where for two years he was consulting engineer to the Rio Tinto and other companies. In 1916 he entered the Ministry of Munitions, taking charge of the transportation of iron ore.

OBITUARY

HOMER SEALS of Miami, Okla., a prominent operator in the Tri-State district, died on Feb. 25.

ROBERT RAINE died recently at Muizenberg, near Cape Town. Mr. Raine had been manager of several Rand mines, notably the New Heriot and the Village Main Reef. He was 75 years old.

WILLIAM MCDONALD, a pioneer in British Columbia copper mining, died recently on Texada Island, B. C., near the old mining town of Vananda, at the age of 71. For years, Mr. McDonald held ownership and rights in several promising copper prospects.

JAMES E. BAILEY, owner of the Good Morning mine, a property in the Boulder district of Colorado, was killed Feb. 27 when a rock weighing 1,500 lb. fell down the shaft and crushed him. Mr. Bailey had gone to the mine to make arrangements for an early spring resumption.

Market and Financial News

A. S. & R. Report Shows Net Earnings Second Only to 1926

Satisfactory Year in Face of Lower Metal Prices—$9,932,367 Expended for New Undertakings and Betterments

AMERICAN Smelting & Refining earned $19.64 per share of common stock in 1927. This is 47c. per share more than in 1925, which had been runner-up to the record year 1926, when $23.38 was earned. Income for 1927 is compared with the preceding year in the following tabulation:

Financial Statement

	1927	1926
Total net earnings	$26,133,601	$28,655,13
Other income	1,837,004	1,496,159
Total income	$27,970,606	$30,151,293
General expenses, taxes	4,026,606	4,027,404
Interest, depreciation	8,466,230	8,363,167
Net income	$15,477,769	$17,760,721
Dividends	8,379,840	8,074,850
Surplus income	$7,097,929	$9,685,871

Unofficial rumors of a higher dividend rate, prevalent a year ago, have been completely subdued by the condition of the major non-ferrous metal markets during 1927.

President Guggenheim declares in his report that "The showing of earnings is quite satisfactory, in view of the fact that metal prices were lower in 1927 than in 1926, and your company is now a substantial miner of lead, zinc, copper, and silver.

"The Quiruvilca copper mine and Shorey smelter, in Peru, have now been in operation a number of months and proven of satisfactory earning capacity, which should be more pronounced hereafter, as the usual initial difficulties have been largely overcome.

"Your company has acquired what is, in effect, a half interest for fifty years in the Buchans mine, in Newfoundland, producing principally zinc and lead, and during that period will manage the mine. A mill is in process of erection, and this property should begin to pay some returns by the latter part of 1928. It will, however, be two to three years before all construction can be completed and full earning capacity realized."

Comparison of Metal Production

	1927	1926
Gold, oz.	1,479,899	1,634,158
Silver, oz.	80,671,759	85,482,438
Lead, tons	476,988	469,607
Copper, tons	536,830	525,897
Zinc, tons	52,170	48,723

Operating Statistics Compared

	1927	1926
Number of men employed	27,363	28,612
Charge smelted, tons	4,643,306	5,433,547
Bullion refined, tons	1,004,196	990,295
Coal used, tons	413,366	413,351
Coke used, tons	492,171	508,033
Barrels of fuel oil used	1,627,258	1,836,923
Gas used, 1,000 cu.ft.	6,402,907	6,223,869
Ore mined, tons	2,234,880	1,875,991
Coal mined, tons	810,329	749,646
Coke produced, tons	366,909	360,270

For new undertakings and betterments $9,932,367.32 was spent during the year, without additional financing.

Total current and miscellaneous assets decreased $1,031,879.35 in 1927 and miscellaneous liabilities decreased $127,875.24. Total current and miscellaneous assets, at $96,093,277.68, are almost five times current and miscellaneous liabilities of $19,546,434.75.

Imports and Exports of Ores and Metals in January, 1927 and 1928

Compiled from U. S. Department of Commerce Records
In Pounds Unless Otherwise Stated

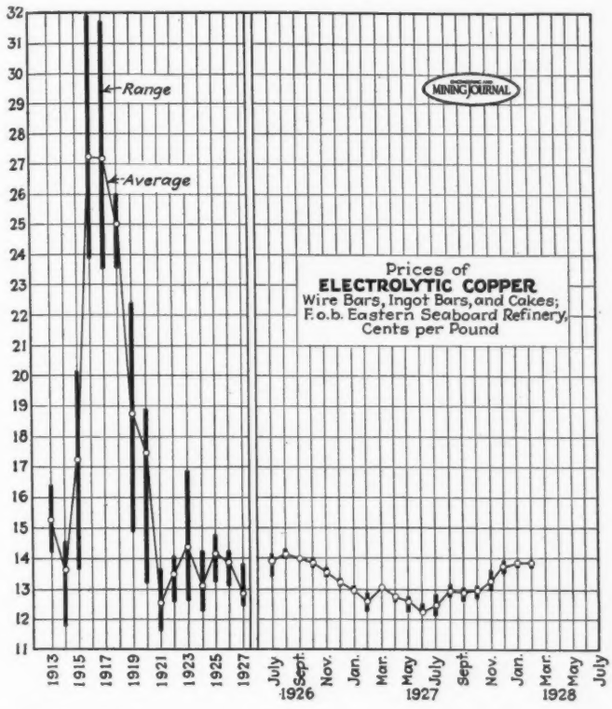
Imports

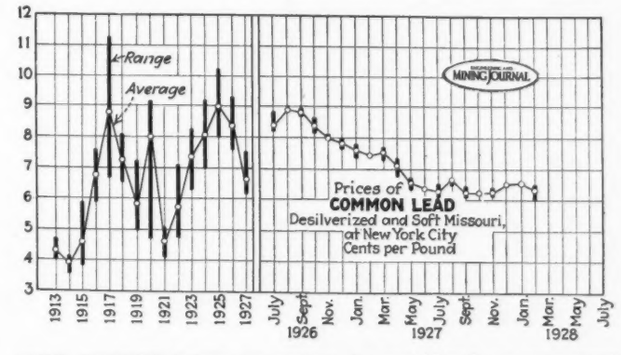
	January 1927	January 1928
Antimony:		
Ore, Gross weight	54,320	49,800
Ore, Antimony content	30,120	20,920
Liquated regulus or metal	2,465,512	1,029,948
Copper		
Ores, copper content	16,948,089	8,686,607
Concentrates, copper content	3,330,590	2,515,260
Regulus, coarse metal, cement copper	32,500	220,700
Imported from		
Spain	2,121,005	1,618,587
Canada	3,952,549	3,949,456
Mexico	5,062,150	3,686,564
Cuba	2,160,000	806,100
Chile	5,725,003	733,766
Peru	1,110,738	92,526
Other countries	179,734	535,568
Unrefined black, blister, converter copper in pigs, bars, and other forms	30,149,513	35,802,711
Refined copper	14,193,534	5,319,153
Old and clippings for remanufacture	445,937	1,170,028
Composition metal, copper chief value	11,200	.....
Brass		
Old and clippings for remanufacture	445,937	775,684
Lead		
Ore and matte, lead content	11,295,781	2,786,480
Bullion or base bullion	12,608,647	18,041,226
Pigs, bars, old and scrap	1,831,841	8,880
Babbitt, solder, and other forms, lead content	63,583	83,708
Manganese		
Ore, tons, Cuba, manganese content	.....	84
Ore, tons, Other countries, manganese content	16,159	9,292
Pyrites, tons	17,840	53,505
Tin		
Ore, tons	9	3
Bars, blocks, pigs	17,842,996	12,828,385
Imported from		
Netherlands	2,077,041	1,627,182
United Kingdom	1,756,312	1,528,706
British Malaya	12,832,196	9,179,602
Netherland East Indies	175,046	114,270
Hongkong	381,256	33,716
Australia	112,000	112,000
Other countries	509,145	232,909
Zinc		
Ore, zinc content, Free	.....	22,549
Ore, zinc content, Dutiable	5,714,137	289,100
Blocks, pigs and old	2,285	.....

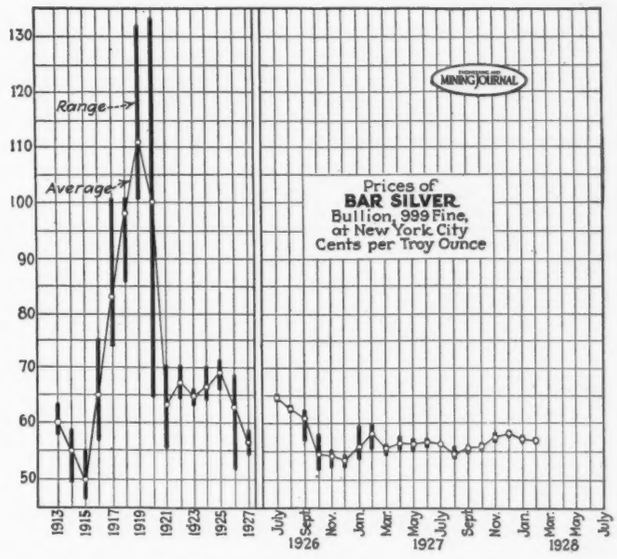
Exports

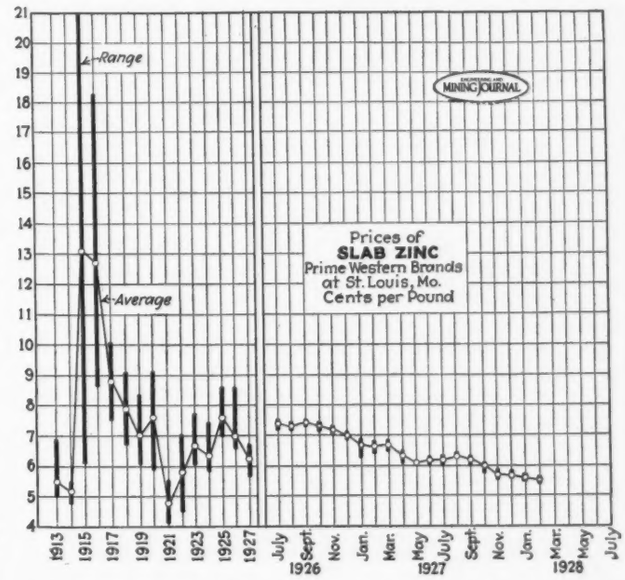
	January 1927	January 1928
Copper		
Ores, composition, concentrates, unrefined	572,165	216,410
Refined copper in ingots and other forms	78,126,677	91,415,483
Exported to		
Belgium	8,126,930	8,097,051
France	5,516,682	17,187,724
Germany	19,017,276	21,860,797
Italy	9,300,940	8,318,636
Netherlands	6,311,314	10,507,733
Spain	380,446	672,398
Sweden	1,596,285	1,562,381
United Kingdom	20,795,158	15,898,813
Other Europe	651,143	4,519,766
Canada	1,456,455	1,376,781
British India	819,661	168,000
China, Hongkong, and Kwantung	492,800	208,576
Japan	3,247,471	839,758
Other countries	414,116	196,619
Old and scrap	3,487,793	4,965,528
Pipes and tubes	181,836	161,668
Plates and sheets	989,970	645,691
Rods	4,025,678	5,776,206
Wire	833,462	1,224,580
Insulated copper wire and cable	1,450,901	1,304,452
Lead		
In pigs, bars, and other forms	.....	.....
From domestic ore	189,818	98,092
From foreign ore	11,699,444	17,586,140
Exported to		
Belgium	.....	1,100
France	336,074	1,008,161
Germany	2,576,483	4,738,816
Netherlands	784,190	1,322,043
Sweden	806,702	1,131,885
United Kingdom	3,979,305	5,153,295
Other Europe	1,010	280,105
Brazil	560,089	396,481
Other South America	1,503,741	263,979
China, Hongkong, and Kwantung	672,294	560,438
Japan	560,268	2,746,706
Other countries	109,106	81,223
Other lead manufactures	2,540,639	1,256,399
Zinc		
Ores and concentrates, tons	10,172	2,064
Dross	1,069,120	264,707
Cast in slabs, blocks, and pigs	5,663,818	9,287,924
Exported to		
Belgium	100,184	221,216
France	179,276	1,282,361
Germany	324,890	1,633,722
Italy	392,097	67,224
Netherlands	103,196	395,076
United Kingdom	3,415,768	313,595
Other Europe	235,243	134,377
Argentina	842,304	1,191
Japan	.....	4,884,442
Other countries	70,860	354,720
Sheets, strips, other forms	627,074	620,160
Dust	274,595	194,477
Other zinc manufactures	202,084	187,102

Metal Price Curves

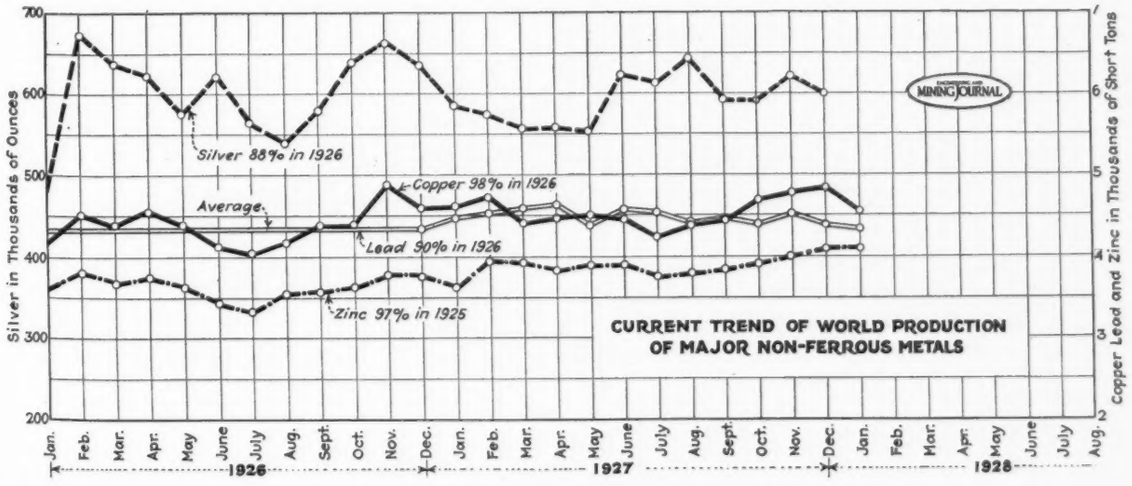








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly a horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.



Review of Current Statistics

CONTINUED WEAKNESS of the major non-ferrous metals is largely responsible for the downward trend of *Engineering and Mining Journal's* statistical indices for February. Lower prices for all the non-ferrous metals, except nickel and aluminum, which remain unchanged from January, are reflected in the lowering of the Weighted Index of Non-Ferrous Metal Prices to a point below the average for 1927. Lead is the chief factor in the decline, zinc, tin, copper, and silver contributing, to a less extent, in the order named. Copper is more than 1c. per pound higher than a year ago, and its weight in the compilation is all that prevents the Index from establishing a new low record.

The primary producers of copper held firmly at a basis of 14⅛c. delivered in Connecticut. Custom smelters sold copper below this price throughout the month. Some sales were reported as low as 13⅞c. Average daily volume of sales for the month was a little higher than in January, though still below normal. Sellers are convinced that an important buying wave may start at any moment. Stocks on hand at the plants of consumers are dwindling. Production rates both in the world and in North and South America decreased appreciably in January and stocks of blister and refined were somewhat lower at the end of the month. Domestic deliveries increased, but this was offset by a decline in foreign shipments.

For nearly three months the "battle" between the big primary copper producers and the consumers has been raging without a decisive victory of either side. The producers have held their ground with remarkable firmness, and have sold some copper at their price. Consumers, on the other hand, have been able to satisfy their urgent needs—for the most part—from customs sellers at concessions from the producers' prices. Even granting that the active buying of October and November may have put them in a slightly over-bought position, and that their own customers are slow about placing orders, it seems certain that they will be forced soon to begin buying copper in larger volume than in the last twelve weeks. Reports are that there is no serious shrinkage in the rate of production of brass manufactures; and increased activity in the automobile industry cannot but be a favorable factor. Mine and smelter production seem to be well in hand, and producers feel that the outcome of the contest with the consumers of raw copper should eventually be in their favor.

Lead has been weak, and the 6c. figure established by the American Smelting & Refining Company on Feb. 29 is the lowest contract price quoted by that company since July, 1923. Persistent weakness in London has been a controlling factor in the lead situation, and there has constantly been the threat of foreign bullion lead being sold in the domestic market. The smelting company reduced its price, in four steps, from 6½c. to the present level. The statistical position of lead has been somewhat unfavorable; production rates declined slightly in January, but stocks remain very large. Some observers feel that the market is "bottomed," at 6c. unless further pressure from abroad should materialize.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54

	1926	1927	1928
July	109.08	95.42	——
August	110.22	97.25	——
September	109.27	96.01	——
October	106.20	95.36	——
November	104.21	96.22	——
December	102.31	98.30	——
January	112.66	100.46	97.54
February	111.91	100.01	96.73

Zinc was weak in February. Late in the month slab zinc was sold as low as 5.40c., St. Louis basis, but several large producers withdrew from the market at that figure and the price has subsequently improved somewhat. Production in the United States was up slightly in January and stocks increased by 1,412 tons. Tin was erratic throughout the month, Straits suffering a net loss of 3.21c. per lb. during February. Increased production is the underlying factor in the weakness of the market, speculative trading in London being responsible for the minor fluctuation. Although the average price of silver was somewhat lower than in January, the metal fared relatively better than the others.

The Non-Metallic Index is unchanged, although markets for the products are, in several instances, rather dull and a number of the price quotations are largely nominal.

Index numbers of all three groups of mining shares declined. The general selling wave which swept over the stock exchanges in February forced many stocks to lower levels, including among its victims a number of well-known mining issues. This general movement, augmented by the prevailing weakness of the non-ferrous metal markets, is largely responsible for the decline in the Index numbers.

In the smelting-manufacturing group, New Jersey Zinc alone shows an increase. This appreciation, in the face of the unsatisfactory zinc situation, may be attributed to the favorable report recently issued by the company and the expectation of the successful expansion of the company's manufacturing interests. International Nickel underwent the greatest depreciation, the common shares dropping nearly 20 points.

Among the coppers, appreciation was shown only by Nevada Consolidated, although Miami and Calumet & Hecla held their own in the face of the general decline. Leaders in the downward movement were Chile, Calumet & Arizona, and United Verde Extension. However, it is well to note that the decline in the Index number for the copper group was less in February than it was in January.

In the miscellaneous group, the same condition holds true, in general, that was observed among the coppers. The miscellaneous Index number decline continued, even more precipitously than in January. Lake Shore, Hollinger, and St. Joe Lead were leaders in the decline. The depreciation noted by Hollinger may be due, in part, to the psychological effect of the recent mine disaster at Timmins, although the rate of decline was the same as in January. Cresson Consolidated Gold was firm, and slight gains were registered by Howe Sound and Premier. This improvement may be the reflection of recent optimistic reports concerning underground conditions at these properties, which have been given wide circulation.

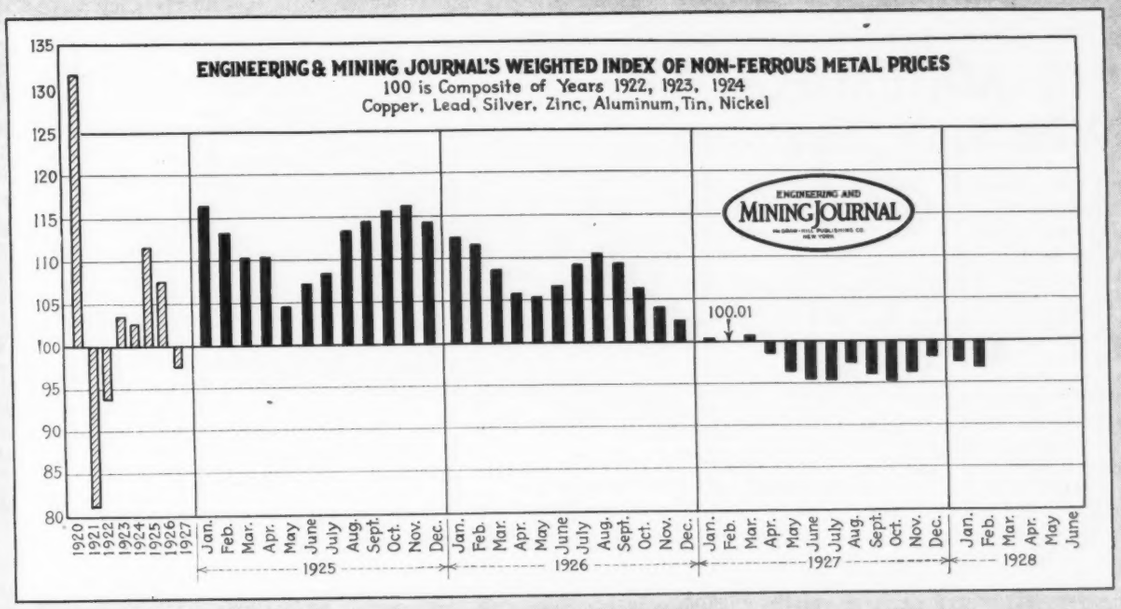
Current Statistics of Production and Stocks of Copper, Lead, and Zinc

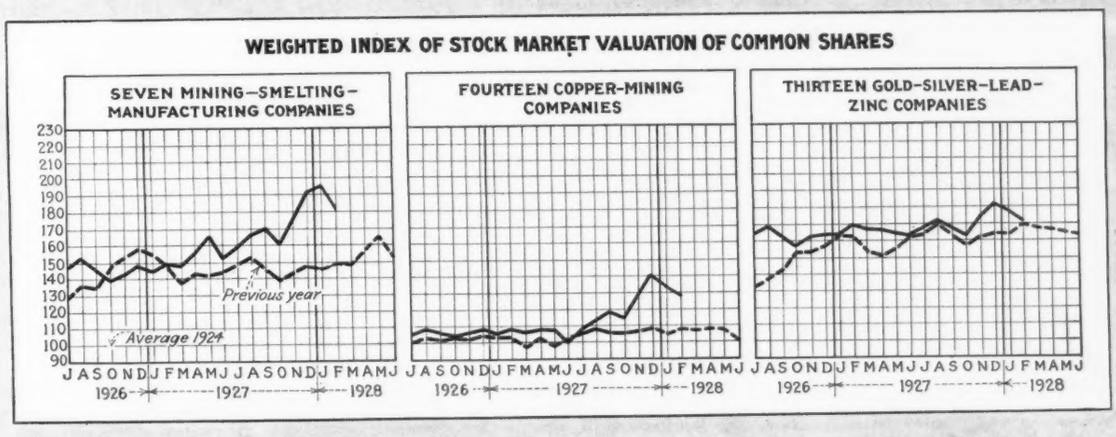
Data from American Bureau of Metal Statistics

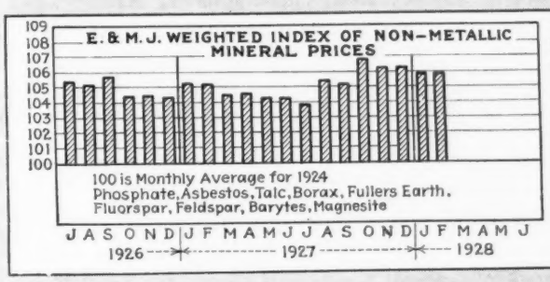
Figures Represent Short Tons

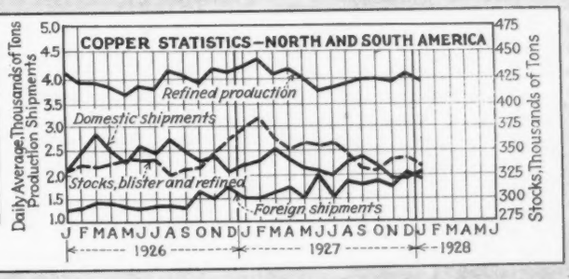
	1927 Average	1927 January	1927 November	1927 December	1928 January
COPPER—North and South America					
Production, refined, daily average	4,045	4,294	3,942	4,159	3,959
Domestic shipments	68,737	76,499	59,264	60,862	64,824
Foreign shipments	53,489	48,130	52,013	63,637	56,721
Stocks, blister and refined	96,728	93,982	90,874	95,298	96,476
LEAD—United States and Mexico					
Production, smelter, daily average	2,513	2,491	2,581	2,517	2,479
Production, U. S. mines, daily average	1,798	1,759	1,901	1,833	1,768
Imports, into U. S. A.	13,451	12,872	14,282	10,587	.....
Stocks, smelter and refinery	156,878	134,682	155,568	156,280	.....
ZINC—United States					
Production, daily average	1,681	1,835	1,641	1,689	1,691
Domestic deliveries	45,811	45,975	44,374	46,483	45,771
Exports, slab zinc	3,468	2,832	2,015	1,042	4,649
Exports, ores and dross	4,424	11,426	526	2,388	2,444
Stocks	37,602	29,912	39,320	40,751	42,163
World Production Rate (Daily average)					
Copper	4,543	4,624	4,733	4,805	4,534
Lead	4,514	4,478	4,579	4,456	4,369
Zinc	3,910	3,910	3,988	4,091	4,113

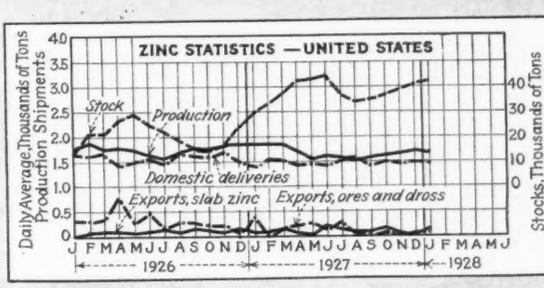
E.&M.J. Statistics of the Mining Industries

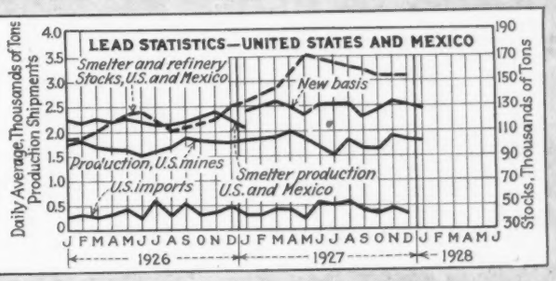





E. & M. J. WEIGHTED INDEX OF NON-METALLIC MINERAL PRICES
100 is Monthly Average for 1924
Phosphate, Asbestos, Talc, Borax, Fullers Earth, Fluorspar, Feldspar, Barytes, Magnesite
1926
1927
1928







The Market Report

Metal Markets Brisker, With Some Improvement in Prices

New York, March 7, 1928—Copper and lead have changed hands in excellent volume during the week ending today. The tone of the copper market is improved, and the 14.125c. price (Connecticut delivery basis) of the leading producers, which has been more or less nominal for many weeks, has been realized on large tonnages yesterday and today. Lead has been particularly active, though the price in New York is virtually unchanged. Zinc has been quiet, but sellers have not pressed their offerings, and business has been done at somewhat higher levels than last week. Moderate consumer buying of tin, with little change in price, is reported. Antimony, quicksilver, and the platinum metals are dull, with a softening tendency in prices Silver is unchanged.

Daily Prices of Metals

Mar.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
1	13.70	50.875	51.375	5.95@6.00	5.75	5.45@5.475
2	13.675	51.00	51.50	6.00	5.75	5.475
3	13.70	51.125	51.625	6.00	5.75	5.45
5	13.725	51.625	52.125	5.95@6.00	5.75	5.45@5.50
6	13.775@13.90	51.125	51.50	5.95@6.00	5.75@5.80	5.50
7	13.875	51.00	51.50	6.00	5.80	5.50 5.55
	13.752	51.125	51.604	5.988	5.763	5.481

Average prices for calendar week ending March 3, 1928, are: Copper, 13.708; 99 per cent tin, 50.979; Straits 51.646; N. Y. lead, 6.029; St. Louis lead, 5.783; zinc, 5.458; and silver, 57.146.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Mar.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
1	60 1/16	59 15/16	66	228 3/4	231 3/8	19 3/8	19 13/16	24 13/16	24 13/16
2	60 1/8	59 15/16	66	229 1/2	231 3/4	19 1/2	19 15/16	24 3/4	24 3/4
5	60 5/8	60 1/2	66 1/4	232 1/4	234 5/8	19 3/4	20 3/16	25	25 1/8
6	61	60 7/8	66 1/2	231 7/8	234 1/4	20 1/4	20 5/8	25 3/16	25 1/16
7	60 7/8	60 11/16	66 1/2	230 1/4	232 3/4	19 15/16	20 5/16	25 1/8	25

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
1	4.87 1/2	57 1/8	26 1/8	84s11 1/2d	5	4.87 3/8	57 1/8	26 3/16	84s11 1/4d
2	4.87 5/16	57	26 1/8	84s11 1/2d	6	4.87 1/2	57 1/8	26 3/16	84s10 3/4d
3	4.87 5/16	57	26 3/16	.....	7	4.87 3/8	57 1/4	26 1/4	84s11 1/4d
					Avg.		57.104		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cents premium.

Copper at 14.125c.

Copper can almost be said to be firmly established at 14.125c. delivered, in Connecticut today, in spite of one or two sales under that figure.

Last Friday was a big day in point of tonnage, but the prevailing price, on offerings of the "custom" smelters, was 13.875c. On Tuesday all prices between 14c. and 14.125c., Connecticut, were realized and a fair quantity for Middle West delivery was placed at 14.25c. In some instances it is probable that special brands or special shapes were a factor in the sales at the high end of the range. One or two sellers shaded 14.125c. this mroning; but the rest are firm at 14.125c. and most of the business has been at that figure. Total sales have been larger than the aggregate of last week, which, in turn, was the best for a period of twelve weeks. Virtually all of the sellers participated in the business; and deliveries as far ahead as May were specified. Prompt, March, and March-April easily predominated. Foreign business has picked up measurably in the last few days, the Export Association still maintaining its price at 14.50c. c.i.f. The large primary producers feel that the "custom" sellers are now in a comparatively easy position, and that they should be able to maintain the position at 14.125c.

Lead Active at Unchanged Prices

The tonnage of lead sold during the week ending today was the largest in several months. The American Smelting & Refining Company maintained its contract price in New York at 6c., and most of the sales were at that level, although a large tonnage was sold at 5.95c., New York.

Three successive advances in London brought on a regular "old-fashioned buying wave," to quote one of the large sellers. Monday, and particularly Tuesday, of this week carried the brunt of the activity, and there was a tendency toward slightly higher prices in the Middle West. A slight decline in London today served to dampen the ardor of the buying wave somewhat, though the London price still shows an appreciable advance over the quotations of a week ago.

Zinc Quiet and Firm

A report from Joplin that effective measures at curtailment have been taken has contributed to a better feeling in the zinc market. It is believed that a reduction of at least 1,500 tons of concentrate will be made this week, although this is not particularly significant in view of the fact that stocks in the hands of producers are estimated at 60,000 tons. Moreover, reports of curtailment in the past have frequently proved false alarms, so another does

not cause much excitement. Nevertheless, buyers have been inquiring more freely than in recent weeks, and sellers have realized better prices for such modest tonnages as they have been willing to sell. High-grade is quoted at 7.75c., but is still purely nominal.

Little Change in Tin

A firmer tendency in the price of Straits Tin stimulated buying in the domestic market on Monday, but the spurt was short-lived and lower prices since then have not attracted business. Tin of 99 per cent quality is largely nominal in the domestic market. Because of the narrowness in the spread between it and Straits, there is little incentive to use the inferior metal. Prompt, April, May and June deliveries are virtually on a par.

Silver Steady

Conditions remain much the same as during the previous week. India has shown some interest as a buyer at current rates, and it is reported from abroad that moderate dealing both ways has taken place on China account. The market closes quiet and steady.

Mexican Dollars (old Mexican pesos): March 1st, 43¾c.; 2d and 3d, 43⅝c.; 5th and 6th, 43¾c.; 7th, 43⅞c.

Foreign Exchange Steady

Sterling is a shade easier than a week ago. Closing cable quotations on Tuesday, March 6, for other foreign exchanges were: francs, 3.93⅜c.; lire, 5.27½c., and marks, 23.90½c. Canadian dollars are ¾ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

ALUMINUM—Per lb., 98 or 99 per cent grades, price of leading interest, 24.30c.; outside market, 23.90@24.30c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week 10⅜@10½c. Forward positions somewhat stronger.

Cookson's "C" grade, spot, 16⅜c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c.

BISMUTH—Per lb., New York, in ton lots, $2.10. Smaller lots, $2.25 and up.

IRIDIUM—Per oz., $285@$315 for 98@99 per cent sponge and powder. Market dull, prices largely nominal.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $49@$52. Small lots bring up to $56. Absolutely no activity in market.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $80. Dealers and refiners quote the trade for refined metal, per oz., cash, $75@$79. Market very dull.

QUICKSILVER — Per 76-lb. flask, $120.50@$121.51, depending on quantity. San Francisco wires $122.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of March 3.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn; 35@38c. Caucasian, washed, 53@55 per cent, 38.50@40c. Chemical grades unchanged from quotations in the March 3 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.25@$10.50. Western scheelite, $10.50@$10.75. Market dead; prices nominal.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the March 3 issue.

Zinc Price Restored—Lead Lower

Joplin, Mo., March 3, 1928

Blende	
High	$39.85
Premium blende, basis 60 per cent zinc	$37.00@ 38.00
Prime Western, basis 60 per cent zinc	36.00
Slimes and fines, 60 per cent zinc	32.00@ 35.00
Average settling price, all zinc	37.69
Galena	
High	$84.90
Basis 80 per cent lead	72.50
Average settling price, all lead	82.44

Shipment for the week: Blende, 11,693; lead, 2.371 tons. Value all ores the week, $636,170.

Before the final close of the market a week ago a couple of buyers restored the price offerings for zinc to the price current the previous week, and settlements this week were, therefore, on a basis $1 higher than the purchase price quotations reported last week, as practically all other buyers met the restored price. This week an advance of $1 per ton on all grades is reported, and purchases were dragging late today, with the sales finally totaling 9,150 tons.

About two-thirds of this week's blende shipment was from Kansas, sellers desiring to clean their bins ahead of the tax assessment date, which fell on March 1.

Lead prices were lowered $5 per ton, and offerings were on a basis of $72.50 today, with a light tonnage sold.

Joplin, Mo., March 5, 1928

It is reported that the owners of mills operating double-time all discontinued night work on March 3, except the two properties owned in New York—the Anna Beaver company and the Missouri-Kansas Zinc Corporation—and that the managers of these two had acquiesced, and would join the others soon. Following this is a movement that has developed during the past month that promises to bring about the most drastic restriction of output yet undertaken. Buyers, sensing that something was in the air, advanced the price of zinc concentrate $1 per ton today.

Platteville, Wis., March 5, 1928

Zinc Blende	Per Ton
Blende, basis 60 per cent	$37.75
Lead Ore	
Lead, basis 80 per cent lead	$77.50

Shipments for the week: Blende, 687 tons; lead, none. Shipments for the year: Blende, 6,457 tons; lead, 560 tons. Shipments for the week to separating plants, 1,452 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the March 3 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. A few good sales made.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the March 3 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or c.i.f. port of entry, $100 quoted for first quarter, 1928. Spiegeleisen, 19@21 per cent, $31@$32 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 90@94c. f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the March 3 issue.

Metal Products

Rolled copper sheets, lead sheets, nickel silver, yellow metal are unchanged from issue of March 3.

ZINC SHEETS—Reduced to 9½c. per lb., f.o.b. works, effective Feb. 27.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from March 3 quotations.

Iron, Steel, and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $17.50; basic, $17; No. 2 foundry, $17.25.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.90c.

Coke—Per gross ton, Connellsville furnace, contract, $2.85@$3; spot, $2.60@$2.75. Connellsville foundry, contract, $3.75@$4.25; spot, $3.75@$4.25. By-product coke, Ohio and Kentucky, $7.50; Buffalo and Detroit, $9.

Mining Stocks—Week Ended March 3, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	55	54	54⅜	Ja.14, Fe.20 Q	0.75
Arcadian Consol.	Boston	...	...	5¼	...	...
Ariz. Com'l	Boston	5	5	5	Ja. 19, Ja. 31	0.25
Cal. & Ariz.	New York	95⅜	91	92⅜	...	...
Calumet & Hecla	Boston	22½	20⅞	21½	No.30, De.15 Q	0.50
Cerro de Pasco	New York	63½	61⅜	62	Ja.12, Fe.8 Q	1.00
Chile Copper	New York	38⅜	37⅜	37⅞	Ma. 2, Ma. 30Q	0.62
Con. Coppermines	N. Y. Curb	...	...	6	...	...
Copper Range	Boston	16⅛	16	16½	Ap.2, My.2, A	1.00
Crystal Copper	BostonCurb	*66	*59	*65	...	...
East Butte	Boston	1⅛	1⅛	1⅛	Dec. 1919	0.50
Granby Consol.	New York	40	39½	39⅝	Ja.15 Jy. 1 Q	1.00
Greene Cananea	New York	121½	114	119	Nov., 1920	0.50
Howe Sound	New York	47½	44	46½	De.31, Ja.16, Q	1.00
Inspiration Consol.	New York	18½	18	18	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb	2½	2½	2½	...	...
Isle Royale	Boston	12	11⅞	11⅞	Fe. 28, Ma. 15	0.50
Kennecott	New York	82½	80⅝	81⅛	De. 2, Ja 3 Q	1.25
Magma Copper	New York	45⅝	43¾	45	Ma.2, Ap.2 Q	1.25
Mason Valley	N. Y. Curb	1⅜	1⅛	1⅛	...	...
Miami Copper	New York	18⅜	18	18	Fe.1, Fe.15, Q	0.37½
Mohawk	Boston	47¼	46½	47	Ja. 28, Ma. 1 Q	1.00
Montana-Idaho	Spokane	*53	*44½	*45	...	...
Mother Lode Coal	New York	3½	3	3	De.16, De.31	0.25
Nevada Consol.	New York	19⅞	19½	19½	De.16, De.31 Q	0.37½
New Cornelia	Boston	26½	25½	26	Fe. 3, Fe. 20 Q	0.50
Noranda	N. Y. Curb	20½	18½	19⅞	...	...
North Butte	Boston	1½	1	1	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*85	*80	*85	Sept. 1926	0.03
Old Dominion	Boston	...	...	9½	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	...	...	121½	De.17, Ja.3 Q	1.50
Quincy	Boston	13½	13	13	March, 1920	1.00
St. Mary's Min. Ld.	Boston	25⅛	25	25	Fe.10, Ma.10	2.00
Seneca Copper	New York	2⅛	2⅛	2⅛	...	...
Shattuck-Denn	N. Y. Curb	15	13½	14	...	...
Tenn. C. & C.	New York	11	10⅛	10⅜	Fe.29, Ma.15, Q	0.12½
United Verde Ex.	N. Y. Curb	20½	20⅛	20½	Ja.4, Fe.1 Q	0.50
Utah Copper	New York	143	143	143	De.16, De.31 Q	1.50
Utah Metal & T.	Boston	1 1/16	1 1/16	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	1.05	*80	*80	...	...
NICKEL-COPPER						
Internat. Nickel	New York	84¼	75¼	82½	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	...	...	112½	Fe. 17, Ma. 1 Q	0.62½
LEAD						
Gladstone Mtn.	Spokane	*9⅛	*9	*9	June, 1927	0.005
National Lead	New York	128	123	124½	Ma.16, Ma 31 Q	1.25
National Lead pfd.	New York	139½	139	139	Ap.23, My.1 Q	1.50
St. Joseph Lead	New York	41	40	40	Ma.9,Ma.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York	16⅛	15½	16	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	69¼	66⅛	68⅛	Nov., 1920	1.50
Butte C. & Z.	New York	7⅛	5½	5⅝	De. 9, De. 24	0.50
Butte & Superior	New York	11	9⅛	10½	De.16, De.31 Q	0.50
Callahan Zn-Ld.	New York	2⅛	2	2⅛	Ma. 14, Ma. 31	0.50
Consol.Lead&Zinc'A'	St. Louis	12	11⅛	11½	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	...	...	18	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati	112	112	112	Jn.30, Oc.15 Q	1.50
New Jersey Zn.	N. Y. Curb	192	191½	191½	Ja. 20, Fe. 10	2.00
Treadwell-Yukon	Toronto	26.50	25.50	26.00	...	...
United Zinc	N. Y. Curb	...	...	25	...	...
Yellow Pine	Los Angeles	*25	*25	*25	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	3⅜	3⅛	3⅜	...	...
Argonaut	Toronto	*23½	*20	*21	...	...
Barry-Hollinger	Toronto	*88½	*78	*88½	...	...
Central Manitoba	Toronto	1.57	1.40	1.54	...	...
Con.W.Dome L. new.	Toronto	*14½	*12½	*13	...	...
Creason Consol. G.	N. Y. Curb	2¼	2 1/16	2⅛	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	12	10⅝	11⅛	Ma. 31, Ap. 20Q	0.25
Golden Cycle	Colo.Springs	...	...	2	Fe.29, Ma.10 Q	0.04
Gold Hill	Toronto	*25	*23	*25	...	...
Hollinger Consol.	Toronto	17.15	17.00	17.15	Ma. 7, Ma. 24	0.10
Homestake Mining	New York	...	...	69½	Fe.20, Fe.25 MX	1.50
Kirkland Lake	Toronto	1.99	1.56	1.89	...	...
Lake Shore	Toronto	24.20	21.50	23.75	Ma.1,Ma.15 QX	0.20
McIntyre-Porcupine	New York	27½	27½	27½	Fe. 1, Ma. 1 Q	0.25
Portland	Colo.Springs	...	...	...	Ap.6, Ap.15, Q	0.02
Rand Mines	New York	...	...	40⅜	Au.22-29 Am.Sh.1	1.52
Sylvanite	Toronto	3.35	3.25	3.35	...	...
Teck-Hughes	Toronto	9.15	8.25	8.85	Fe.1, X	0.15
Tom Reed	Los Angeles	*33	*31	*32	Dec., 1926	0.02
Tough-Oakes	Toronto	*63	*56	*61	...	...
United Eastern	N. Y. Curb	*55	*55	*55	July, 1924	0.05
Vipond Cons.	Toronto	*56	*53½	*54	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	5.00	4.55	4.96	Ja. 17, Fe. 1	0.05
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	23	22½	23	...	...
Con. Cortes	N. Y. Curb	*23	*19	*23	...	...
Dolores Esperanza	N. Y. Curb	*40	*40	*40	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	...	...	...	...	...
Premier Gold	N. Y. Curb	2⅛	2 1/16	2⅛	De.15, Ja. 4	0.08
Tonopah Belmont	N Y. Curb	...	...	1⅛	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*12	*11	*12	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	4⅛	4	4	Se.20, Oc.21	0.07½
West End Consol.	N. Y. Curb	...	...	*5	Mar., 1923	0.05
Yukon Gold	Boston Curb	...	...	*70	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	1.57	1.28	1.57	May, 1920	0.03
Castle-Trethewey	Toronto	*65	*63	*63	...	...
Coniagas	Toronto	...	...	4.90	May, 1924	0.12½
Keeley	Toronto	*57	*54	*54	Ma. 1, Ma. 15	0.04
Lorrain Trout Lake	Toronto	...	...	*60	July, 1925	0.05
Mining Corp. Can.	Toronto	3.75	3.60	3.70	Ja.10, Ja.25	0.15
Nipissing	N. Y. Curb.	4⅛	4⅛	4⅛	De. 31, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3	2⅞	2⅞	Ma. 25,Ap.4,QX	0.12½
Bingham Mines	Boston	55	55	55	Ja. 21, Fe. 1 Q	0.95
BunkerHill&Sullivan	N. Y. Curb	144½	144½	144½	Fe.29, Ma.5 QX	0.75
Cardiff M. & M.	Salt Lake	*69	*69	*69	F b 5, 1927	0.10
Chief Consol.	Salt Lake	4.50	3.85	3.95	Ja.10, Fe.1 Q	0.10
Consti'nMng.&Mill'g	Spokane	*22	*15	*22	...	...
Erupcion	Boston Curb	*35	*35	*35	De.17, Ja.3 Q	0.07½
Eureka Lily	Salt Lake	2.40	1.75	1.75	...	...
Federal M. & S.	New York	...	...	140	Jn.25, Jn.29	Spec. $10
Federal M. & S pfd.	New York	95	93½	95	Fe 24 Ma.15 Q	1.75
Hecla Mining	N. Y. Curb	17⅜	16⅞	17⅛	Fe.15, Ma.15 Q	0.25
Highland-Surprise	Spokane	*14½	*12	*14½	...	...
Iron King Mining	Salt Lake	*67	*57	*59	...	...
Keystone Mining	Salt Lake	*35	*27	*24	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*40	*39	*39	...	...
Lucky Tiger-Com.	Kansas City	†8.10	†7.90	...	Ma.10, Ma. 20†	0.07
Mammoth Mining	Salt Lake	2.00	1.72½	1.72½	Jn.10, Jn.20 Q	0.05
North Lily	Salt Lake	5.90	5.15	5.25	...	...
Park Utah	New York	11½	10½	11	De. 15, Ja. 3 Q	0.20
Plutus Mining	Salt Lake	...	...	2.65	Oc. 25, No. 10 Q	0.10
Silver King Coal	Salt Lake	11.00	10.87½	11.00	Ma. 20, Apr. 2,	0.25
Silversmith	Spokane	*24	*21½	*21½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*47½	*42	*46	...	...
Sunshine M. Co.	Spokane	1.20	1.10	1.15	Fe.10,Fe.20	0.02
Tamarack-Custer	Spokane	1.18	*93	*98	Sept., 1924	0.25
Tintic Standard	Salt Lake	14.50	14.00	14.50	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	4⅜	4⅜	4⅜	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	59	56⅜	58½	Se. 2, Oc.1	1.75
Cleveland-Cliffs Iron	Cleveland	134	107	111	Ja.13, Ja.25. Q	1.00
Colorado Fuel & Iron	New York	70	66½	69	May, 1921	0.75
Gt. North'n Iron Ore	New York	23	22	22½	Dec. 6, Dec. 28	0.75
Inland Steel	New York	48⅛	46	46	Fe.15 Ma.1 QX	0.66⅔
Replogle Steel	New York	...	...	12½	...	...
Republic I. & S.	New York	60⅞	59	60½	Fe. 15, Ma 1 Q	1.00
Republic I. & S. pfd.	New York	109	107	107	Ma. 15, Ap. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	126	116½	126	De 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	...	...	119	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	140⅝	137⅜	140½	No. 30, De. 30 Q	1.75
U. S. Steel, pfd.	New York	140	139	139½	Oc.30, No. 29 Q	1.75
Virginia I. C. & C.	New York	32	32	32	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York	62⅜	62⅜	62⅜	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York	...	...	24	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	3½	3	3	...	...
Alum. Co. of Amer.	N. Y. Curb	127½	125½	126	...	...
Alum. Co. ofAmer.pf.	N. Y. Curb	107½	106½	107½	De. 15, Ja1 Q	1.50
Vanadium Corp.	New York	79½	74½	78½	Fe. 1, Fe. 15 Q	0.75
Patino M. & E.	New York	25½	24½	24½	De. 31, Ja. 14	4s.
ASBESTOS						
Asbestos Corp.	Montreal	33¼	34¼	32½	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	93	93	93	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport Texas	New York	72	68½	70¾	Ja.14, Fe.1 QX	1.75
Texas Gulf	New York	72⅜	70	71½	Ma.1, Ma.15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	41	40	40	Fe.18, Ma.1 Q	0.75
Amer. Metal, pfd.	New York	118½	117½	118½	Fe.18, Ma.1 Q	1.75
Amer. Sm. & Ref.	New York	173½	169	171	De.31, Fe. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	134½	133	133½	De.31, Ma.1 Q	1.75
Consol. M. & S.	Montreal	270	265	268	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	158½	155½	157⅜	Ja.3, Ja. 17	1.00
U. S. Sm. R. & M.	New York	40½	39½	39⅞	Ja. 6, Ja. 14 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	53	52½	53	Ja. 6, J3 14 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED FEBRUARY 21, 1928

Name	High	Low	Last	Date	Last Div. Amount
Aramayo Mines (25 frs.)	70/—	65/—	70/—	Feb., 1928	5 p.c. (†)
British Platinum (£1)	—/3	—/1½	—/3	Feb., 1925	2½ p.c.
Burma Corpn. (10 rupees)	13/4½	13/—	13/3	Jan., 1928	6 annas*
Bwana M'Kubwa (5s)	4/6	4/—	4/6	...	...
Camp Bird (2s)	3/6	3/1½	3/3	...	...
El Oro (£1)	4/—	3/4½	3/9	Nov., 1924	2½ p.c.*
Esperanza (10s)	—/1	—/1⅜	—/1	...	...
Frontino & Bolivia (£1)	14/3	13/9	14/—	Jan, 1928	5 p.c.
Mexican Corpn. (£1)	7/6	6/3	7/6	...	...
Mexico Mines of El Oro (£1)	27/6	21/10½	26/3	Dec., 1926	3½ p.c.*
N'Changa Copper Mining	10/—	9/9	10/—	...	...
Oroville Dredging (£1)	4/1½	3/7½	3/9	Dec., 1923	3¾ p.c.
Ouro Preto (£1)	2/6	2/3	2/6	May, 1925	2½ p.c.
Rhodesian Congo Border (£1)	24/4½	20/—	23/9	...	...
St. John del Rey (£1)	10/4½	10/—	10 3	May, 1927	3¾ p.c.
San Francisco Mines (10s)	27/3	26/3	26/3	Jan, 1928	25s.
Santa Gertrudis (£1)	15/4½	14/9	15/3	Jan., 1928	7½ p.c.
Selukwe (2s. 6d.)	6/10½	6/3	6/9	April, 1917	6¾ p.c.
S. Amer. Copper (2s.)	1/1½	—/10½	1/—	Nov., 1917	75 p.c.
Tanganyika (£1)	71/9	59/4½	61/10½	Aug., 1927	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	11.490	11.025	11.490	July, 1927	182.60(‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.